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United States
Department of
Agriculture

Forest Service

Pacific Northwest
Research Station

Research Paper
PNW-355
March 1986



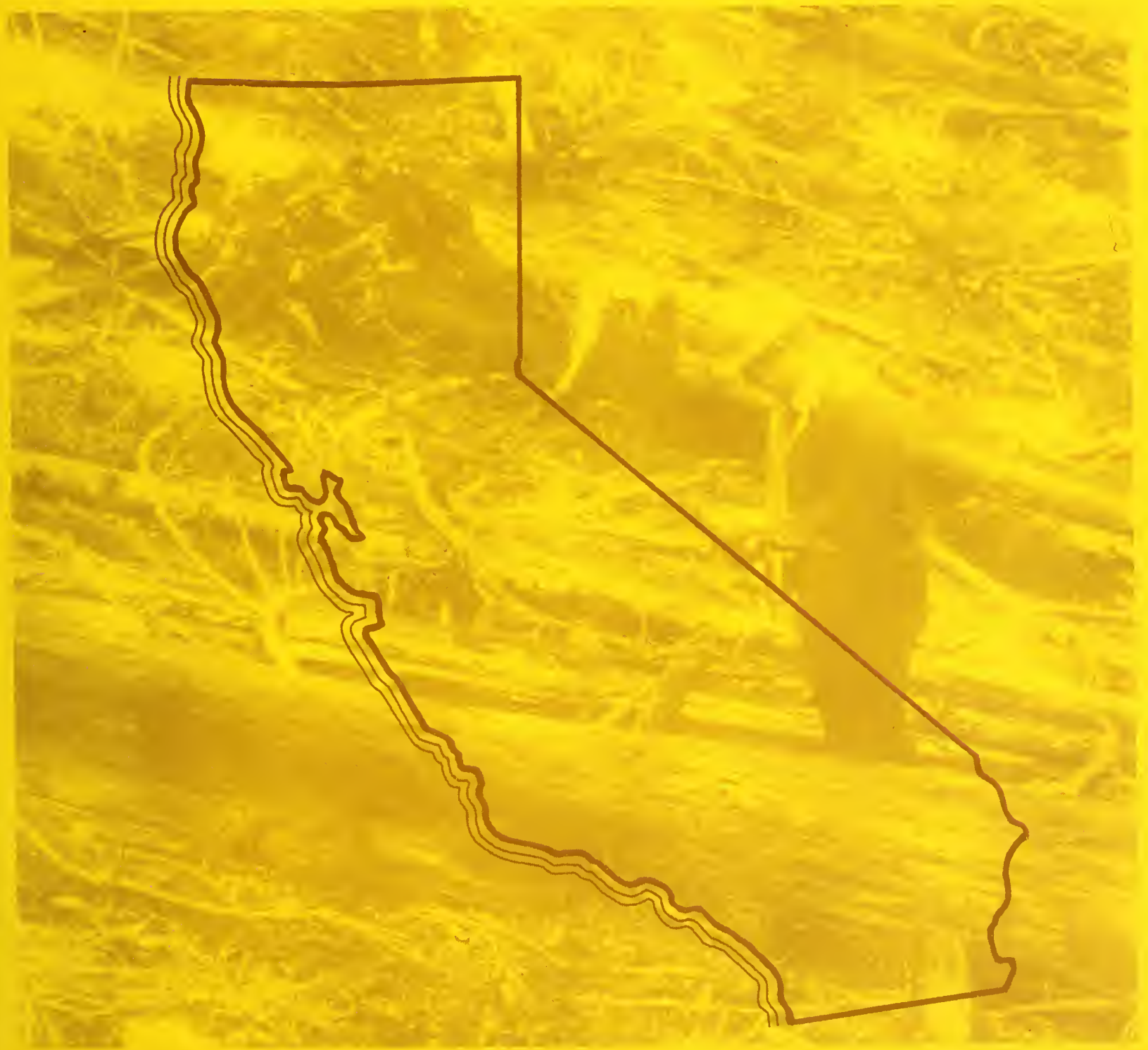
Estimators and Characteristics of Logging Residue in California

James O. Howard and Julianne K. Bulgin

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Abstract

Howard, James O.; Bulgrin, Julianne K. Estimators and characteristics of logging residue in California. Res. Pap. PNW-355. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; **1986**. 81 p.

Ratios are presented for estimating volume and characteristics of logging residue in California. The ratios relate cubic-foot volume of residue to thousand board feet of timber harvested and to acres harvested. Tables show gross and net volume of residue, with and without bark, by diameter and length classes, by number of pieces per acre, by softwoods and hardwoods, by percent soundness, and by degree of slope and distance to roads.

Keywords: Slash, residue management, residue estimation, California.

Summary

Increasing interest is being focused on logging residue for production of energy and for conventional wood fiber products in California. The result is a rapidly growing number of assessments being made to determine the feasibility of utilizing logging residue to supply wood fiber for a specific conversion facility. These site-specific analyses require detailed information on residue volume and characteristics. Existing sources do not provide this type of information on a statewide basis. This study provides the capability to make estimates of the volume and characteristics of residue throughout the State of California.

This study had two objectives. The first was to develop estimates to determine the volume of logging residue for any specific location in California. These estimators are in the form of ratios that relate the quantity of residue to timber harvest volume or acres. The second objective was to provide data on the characteristics of logging residue that affect the potential utilization for energy or other products.

The information in this report is based on measurement of logging residue on 220 cutover areas in California. The sample areas were allocated among eight strata, based on geographic area, owner-harvest method, and forest type.

Results are shown for each of the eight strata. Tables show gross and net (chippable) volume, with and without bark. An example of how to apply the data is provided.

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Introduction



There is great interest in California in using woody material as an alternative fuel for energy production. Numerous sites have been examined for power generation opportunities. In some cases—Burney, Westwood, and Oroville—construction of energy producing facilities has been completed or is underway. This high level of activity stems from a growing demand for electricity and a favorable rate structure offered by the utilities for purchased power.

One source of woody material receiving much attention is logging residue.^{1/} Logging residue presents a large quantity of wood fiber potentially available for energy. A benefit of using residue for energy is the mitigation of some problems facing forest managers.

There is, however, a lack of comprehensive, up-to-date data for logging residue for California. The most recent statewide statistics were published in 1973 (Howard 1973). In addition to being outdated, these data do not allow for site-specific estimates of residue volume tied to current or future timber harvest. This capability is particularly important in light of the numerous sites throughout California that are, or may be, considered for power generation, including cogeneration options. Site-specific analyses of logging residue also require more detailed information about the characteristics of residue materials than is available in the 1973 data. Crucial questions about costs, equipment, handling, and transportation require a data base that provides information on size, number of pieces, distribution, and quality of these materials. This type of information may exist for some areas and owners, but there is no compatible data applicable to all lands where timber harvesting occurs. Even more critical to making reliable estimates of costs and feasibility of use, is that existing data sources are based on differing standards, definitions, and sampling designs.

The California study was designed to meet the needs of site-specific analysis of logging residue throughout the State of California. The development of reliable, uniform data will enable the forest products and power generating industries to gauge the economic feasibility of accelerating the use of logging residue for energy. An additional benefit is to provide parity in residue information with other western States (Howard 1981a, 1981b, 1984), thereby aiding regional energy planning and development efforts.

The study had two primary objectives. The first was to develop appropriate analytical tools for estimating the volume of logging residue for any uniquely defined supply zone in California. Volume estimators (ratios) developed in this study relate residue volume to both volume and acreage of timber harvest. One ratio gives the cubic-foot volume of residues associated with the harvest of 1,000 board feet of timber (CF/MBF). The other ratio gives cubic-foot volume of residue per acre harvested (CF/AC). An example is provided to demonstrate practical application of these ratios.

^{1/} See Glossary for terms used in this report.

The second objective was to estimate logging residue by the following classifications that affect utilization:

1. Gross and net volume, by diameter and length classes, for live material and for dead/cull material.
2. Number of pieces per acre, by diameter and length classes.
3. Volume, by percent sound (chippable), in cubic feet per acre.
4. Accessibility on cutover areas, by slope and distance to road.
5. Volume, by softwoods and hardwoods.

Ratios and characteristics for residue are displayed for eight strata in California, based on geographic area, owner class-harvest method, and forest type. These strata were selected on the basis of differences in residue volume associated with harvesting methods and existing information on residue characteristics (Howard 1973).

Results are based on measurements of logging residue on 220 cutover units made during summer 1984.

Study Design

Designing the study included the following steps: (1) choosing a sample design, (2) determining sample size and selecting cutover areas to be sampled, (3) establishing procedures for sampling and measuring residue volume and characteristics, and (4) selecting estimation procedures for computing ratios and residue characteristics. This process is discussed below.

Sample Size and Allocation

Sample stratification was based on timber ownership, geographic area, harvest method, and forest type. An evaluation of harvest data indicated that there were eight significant classes of owner and harvest methods in California. Only two classes of ownership, public and private, were identified. Most of the timber harvest on public land is in National Forests, and most of the harvest on private land is on industry-owned land. There was not enough harvest in any other ownership class to warrant a separate stratum. The State was divided into two geographical areas: coastal California and interior California (see fig. 1). The line dividing coastal and interior California roughly separates the redwood-coastal Douglas-fir zone from the rest of the State. In terms of harvest method, enough timber is harvested by clearcutting to justify separate strata for all sectors except the interior private sector and the ponderosa pine zone. Estimates of residue volume and characteristics of the interior private stratum represent the mix of harvest methods that were used at the time of the study. This mix is not expected to change much from year to year.

A separate stratum based on forest type was used for ponderosa pine. Information from various landowners indicated that harvest residue in the ponderosa pine type exhibits significantly different volume relationships and characteristics from that of other forest types. Additionally, because ponderosa pine typically occur in large stands across eastern California, annual harvest volume and acreage can be identified in the data bases of major land owners.

Line Transect
STRATA
CUBIC FEET
clearcut
Sub-sample
LENGTH
 $N = \frac{CV^2 t^2}{A^2}$
number of samples

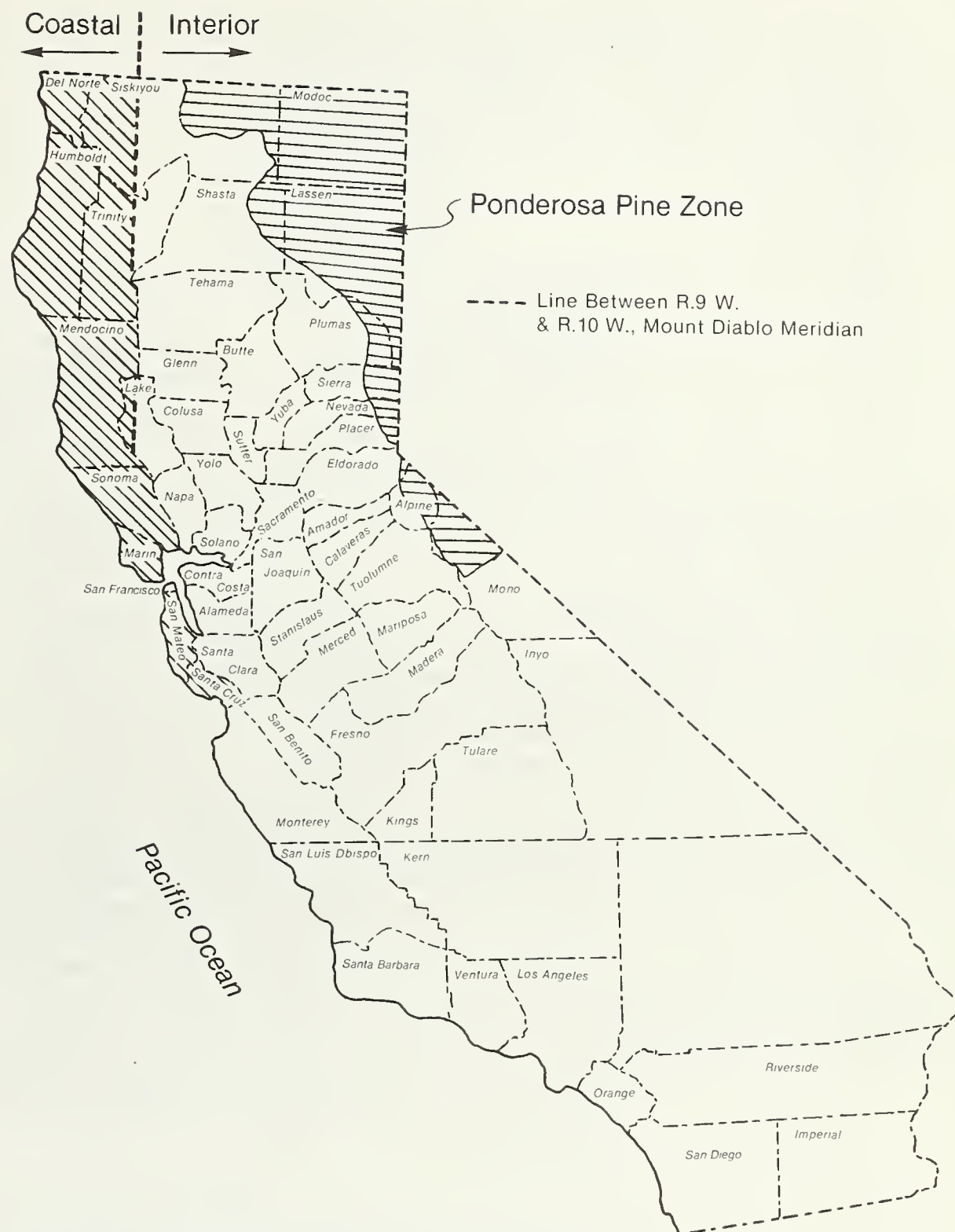


Figure 1.—Geographic stratifications used for residue sampling in California.

The eight strata identified for the study were:

Coastal:	Public, clearcut
	Public, partial cut
	Private, clearcut
	Private, partial cut
Interior:	Public, clearcut
	Public, partial cut
	Private, all harvest methods
Ponderosa pine:	All ownerships and all harvest methods

Following identification of study strata, sample size was determined for each stratum by computation or rule-of-thumb, depending on available information.

Where information was available from which to estimate expected variation, sample size was determined by the following formula:

$$N = \frac{CV^2 t^2}{A^2} ;$$

where:

N = stratum sample size,
CV = coefficient of variation,
t = Student's t-value, and
A = desired level of precision.

The values for t and A were fixed so that the computed sample size would result in an estimated average residue volume per stratum within ± 20 percent of the true average 9 times out of 10 (90 percent confidence level). Coefficient of variation for logging residue volume (per acre) was used to compute sample size. This was done because the major contributor to total variance was assumed to be that associated with average residue volume (per acre). Values for CV were derived from previous studies where similar population characteristics were observed (Howard 1973, 1981a).

For the ponderosa pine stratum there were no comparable data from which to derive estimates of variation. For this stratum, sample size was set at 25. This number was considered adequate to provide results comparable to those from the other strata.

The sample size determined for each stratum is shown below:

<u>Geographic area</u>	<u>Owner and harvest method</u>	<u>Number of samples</u>
Coastal	Public, clearcut	25
	Public, partial cut	25
	Private, clearcut	27
	Private, partial cut	30
Interior	Public, clearcut	25
	Public, partial cut	28
	Private, all harvest methods ^{2/}	35
Ponderosa pine	All owners and all harvest methods ^{3/}	25
Total		220

Sample Selection

Specific cutover areas were selected following determination of sample size for each stratum. The basic approach was to identify all cutover areas (the sample population) by stratum. The desired number of samples was then selected from this population.

The overall sampling scheme for the study was a two-stage sample, with PPS (probability proportional to size) sampling as the first stage. The second stage, residue sampling on each cutover unit, will be discussed later. In the first stage, PPS sampling was conducted for each of the eight strata. Following PPS sampling procedures, all qualifying cutover units were listed, along with acres harvested. These acreages were accumulated, and random numbers were used to select specific units for sampling. Under this procedure larger cutover areas have a greater chance of being selected because each acre, in effect, has equal weight. Because sampling was done with replacement, some cutover units were selected more than once. For these units, residue measurements were made once, then replicated for each additional time the unit was selected.

Determining the sample population generally followed one of two procedures. For some ownerships it was possible to obtain a list of all areas cut over during the study period, January 1, 1983, to September 30, 1984. For other owners it was more efficient to use lists of only those cutover areas that met study criteria. Sample units were selected from the lists provided by landowners.

^{2/} Samples were selected from all harvest methods; most samples were from partial-cut areas.

^{3/} Samples were selected from all harvest methods and ownership classes; most samples were from public partial-cut areas.

All cutover areas selected, regardless of which procedure was used, had to meet five criteria to be considered for study. Criteria were:

1. Logging was completed after January 1, 1983, and prior to September 30, 1984.
2. The unit was 5 acres or larger.
3. Residue on the unit had not been burned following logging.
4. The unit was not a fire salvage sale.
5. Logging residue on the unit had not been utilized by cull log salvagers, firewood cutters, or secondary operators.

These criteria were established to ensure that residue estimates would be representative of normal harvesting situations.

A larger number of sample units was selected than was dictated by the sampling process described. The extra units served as alternates to replace areas that failed to meet study criteria upon field examination. Alternate sample units for each stratum were used in the order in which they were drawn.

Following identification of the cutover areas to be sampled, each owner was contacted and asked to provide maps, location data, and information concerning characteristics of the area.

Specific information collected for each sample was:

1. Age of the timber harvested.
2. Acreage of the area harvested.
3. Type of logging equipment used.
4. Percentage contribution of the three major species harvested (set to 100 percent).
5. Volume of timber harvested, in thousand board feet per acre.

The average volume of residue on each cutover area was estimated using three procedures. The line intersect method was used to obtain an estimate for scattered materials and small piles (Howard and Ward 1972). A pile volume estimator, obtained from a separate study, was used to determine the volume in large piles (Little 1982). The volume of bark was derived by using bark-to-wood factors, which were obtained from a companion study (Snell and Max 1982). Information on characteristics of the residue was derived from a subsample of pieces measured for volume estimation.

Estimating scattered residue.—The line intersect method was used to estimate the volume of all residue material 3.01 inches in diameter inside bark (d.i.b.) and larger and 1.0 foot in length and longer that was not found in large piles. The line intersect method has been widely used for estimating residue and has been demonstrated to be efficient and unbiased (Pickford and Hazard 1978).

The sample design used in this study consisted of 200-foot line transects located at each of 30 points on a systematic grid (fig. 2).

Residue Sampling Techniques

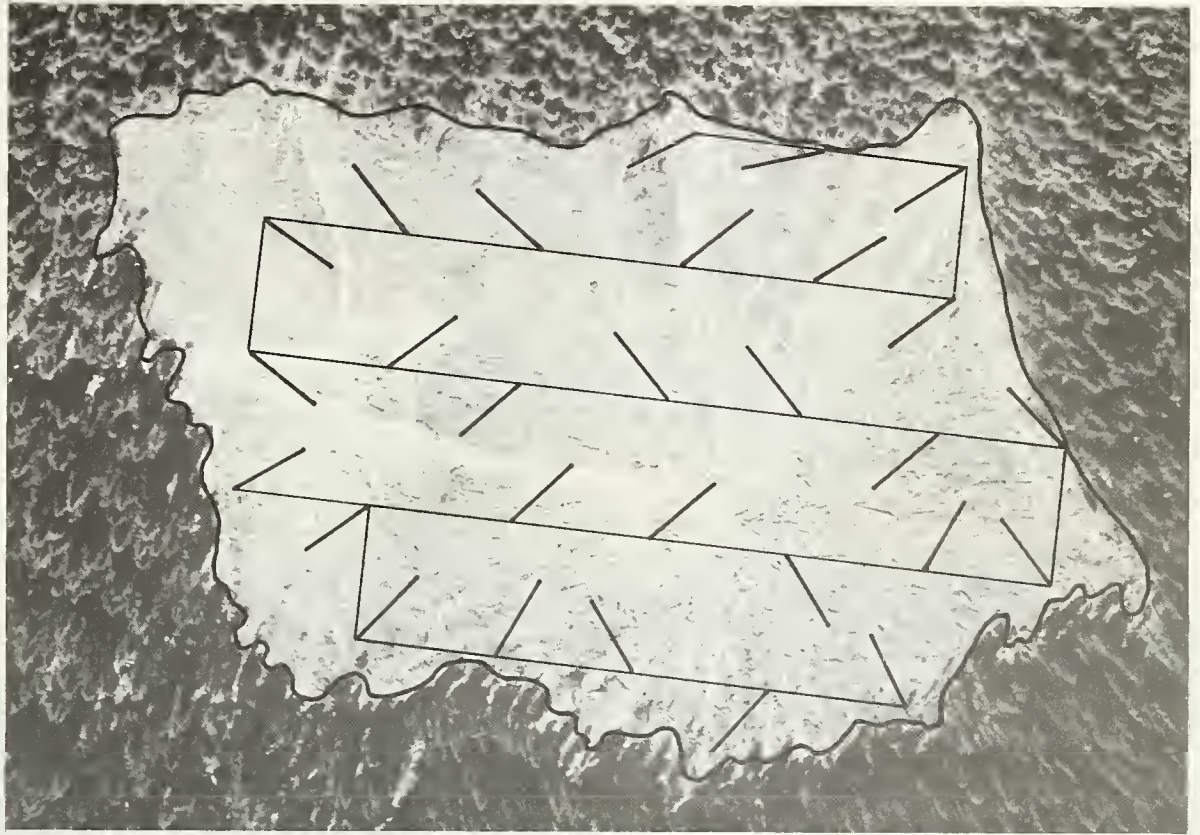


Figure 2.—Example of sampling grid for a cutover area.

The interval between grid points varied with size of the cutover area. Except on very large partial cuts, the fluctuating grid interval resulted in a pattern that covered the entire cutover area. The maximum grid interval was set to cover about 200 acres. For larger areas, yarding practices are such that residue piles are created throughout the area, rather than at a central location. Both scattered residue and piles tend, therefore, to be associated with the surrounding harvesting pattern. Thus, the sample design used in this study results in estimates of residue that are representative of the harvest practice within the grid pattern.

To reduce bias, both the initial starting point and the base line for the grid system were randomly selected. To reduce piece orientation bias (Howard and Ward 1972), each of the 30 line transects was randomly oriented along 45-degree azimuths.

Measurements were taken for all qualifying residue intersected by the 200-foot line transects. Only pieces at least 3.01 inches d.i.b. and 1.0 foot in length were considered measurable. Older dead pieces that were rotten to the point of losing their original form were excluded (fig. 3).



Figure 3.—Deteriorated logs, such as this, were not included in the study.

Measurements recorded for each piece of residue were:

1. Diameter (i.b.) at the point of intersection with a transect line.
2. Net chippable content at the point of intersection with a transect line.
3. Origin of the piece (live or dead/cull at the time of harvesting).

These are the only measurements required to provide an estimate of gross and net volumes of scattered logging residue and small piles for a specific cutover area.

Estimating pile volume.—The line intersect method cannot be used to estimate residue in large piles (fig. 4) because many pieces in the interior of such piles are impossible to observe without taking the pile apart. Because destructive sampling of piles was not within the scope of this study, a separate procedure was used to estimate pile volume.



Figure 4.—Large piles of residue required separate procedures for estimating volume.

The procedure for estimating the volume of residue in large piles involved two steps. First, each pile was visually classified as one of the four geometric solids shown in figure 5. Then the dimensions appropriated for the selected shape were recorded to the nearest foot. The geometric volume of each pile was computed from these measurements and converted to solid wood content according to procedures described by Little (1982).

Net (chippable) volume and origin of residue in large piles had to be derived by other means. Net volume was estimated by using data from an earlier study (Howard 1978) of residue from the harvest of old-growth timber with characteristics generally similar to those found in this study. The proportion of net volume to gross volume (0.54) from the 1978 study was applied to the gross residue volume of each pile to obtain net volume.

The proportion by live or dead/cull material in each pile was estimated visually by field personnel.

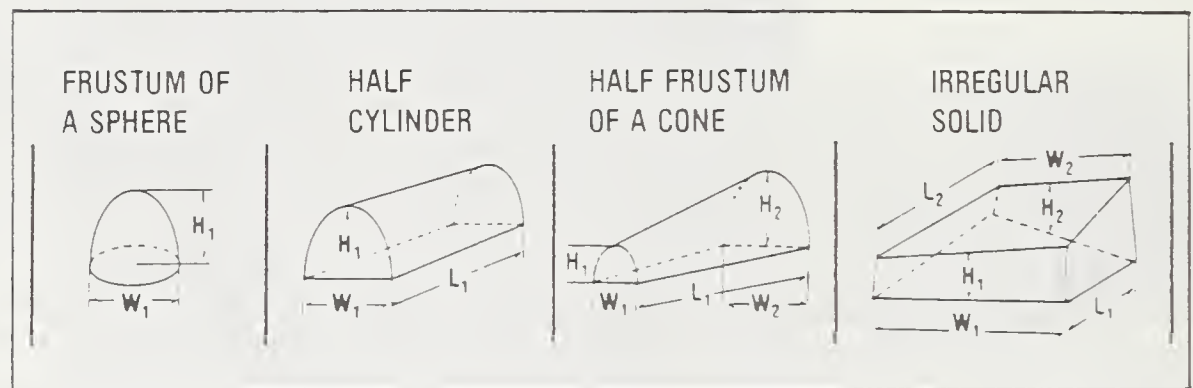


Figure 5.—Geometric solids and related dimensions used for estimating the volume of residue in piles.

Estimating bark volume.—Diameters of residue pieces were measured inside the bark to avoid problems associated with voids when outside-bark measurements are taken (fig. 6). Bark is, however, an important raw material, particularly for energy conversion. Thus another method was required to estimate bark volume. Ratios of bark-to-wood were developed for the major species based on data from a study of bark samples from 50 cutover areas in Idaho, Oregon, and Washington (Snell and Max 1982).

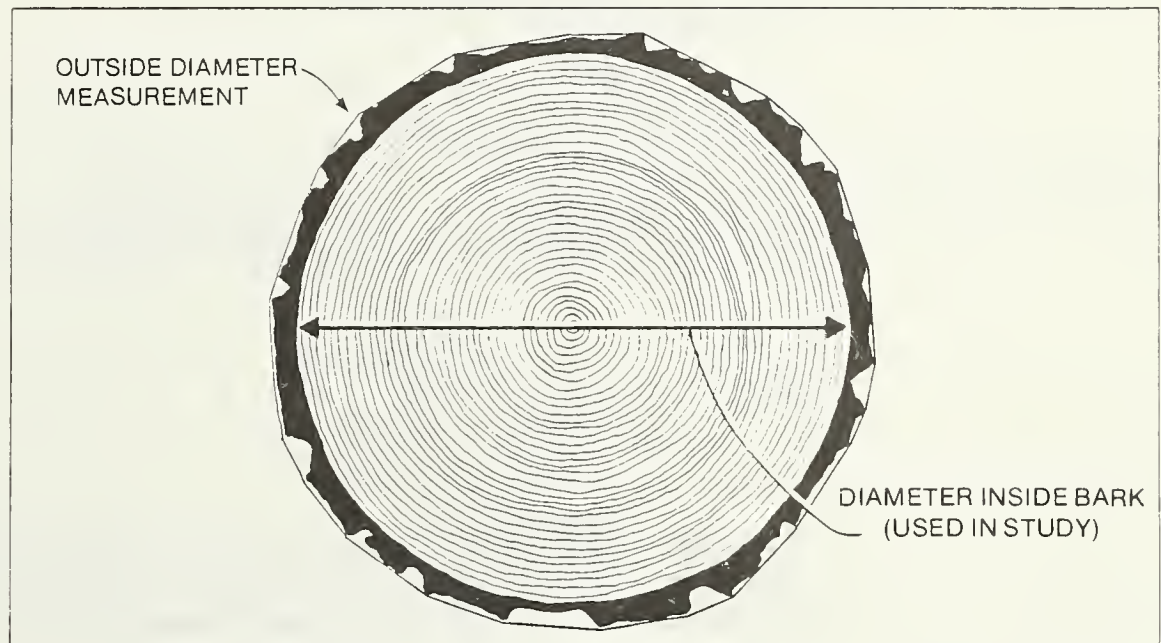


Figure 6.—Voids associated with irregularities in bark were avoided by making inside-bark measurements.

A weighted average bark factor was computed for each sample unit using harvest volume by species. These ratios were then applied to wood residue volume to generate estimates of wood and bark volume.

Estimating residue characteristics.—To provide data on size and number of pieces, additional measurements were made on a subsample of all residue pieces measured to estimate volume. The subsample consisted of all residue pieces encountered on the first 40 feet of each 200-foot line transect. This resulted in a subsample of approximately 20 percent of the total number of pieces measured for volume.

The data recorded for pieces in the subsample were:

1. Diameter (i.b.) at intersection with line transect.
2. Small-end diameter (i.b.), to the nearest inch.
3. Large-end diameter (i.b.), to the nearest inch.
4. Length, to the nearest foot.
5. Net chippable content.
6. Live or dead/cull at time of logging.
7. Softwood or hardwood.

Subsample items 1, 5, and 6 were the same measurements as those recorded for the line-transect volume estimate.

Following completion of the transect measurements, all residue, including large piles, was visually classified by the following slope and distance-to-road categories:

Slope:	0-35 percent
	over 35 percent
Distance to road:	0-500 feet
	501-1,000 feet
	over 1,000 feet

Roads are defined here as any roadbed capable of handling log trucks and other logging equipment. In tractor-logged areas, especially those with flat terrain, acceptable roads are frequently of lower quality than those associated with steeper slopes.

Computational Procedures

The volume of residue recorded by the line intersect method was computed by the following formula:

$$V = \frac{\pi^2 D^2}{8L} \cdot \frac{43,560}{144},$$

where:

V = volume of each piece of residue, in cubic feet per acre;
D = diameter (i.b.) in inches, of each piece of residue; and
L = total length of transect lines (6,000 feet).

The sum of the computed transect volume for each piece yields average gross volume (CF/AC) of residue for a specific cutover area. As discussed above, the volume of piles, where present, was computed separately. To estimate the average volume of wood in piles on a per-acre basis, the total volume of residue in piles for each sample area was divided by the acreage of the area. This figure was then added to the transect volume to obtain the overall gross wood residue volume for each cutover area. Estimates of residue including bark were derived by applying the bark-to-wood ratios described above. Net chippable volume was computed from information collected for each piece tallied along the transects, and from the pile estimation process described earlier.

These computations provided estimates of residue in cubic feet per acre. A major objective of this study was, however, to provide ratios of cubic feet of residue to 1,000 board feet of timber harvested (CF/MBF). To obtain this ratio for a particular cutover area, the average volume of residue (CF/AC) was divided by the average harvest volume (MBF/AC). This is shown by:

$$\text{Ratio}_i = \frac{(\text{Residue volume})_i}{(\text{Harvest volume})_i} = \frac{(\text{CF/AC})_i}{(\text{MBF/AC})_i} = (\text{CF/MBF})_i;$$

where: $i = i^{\text{th}}$ cutover area (sample unit).

Estimating average residue volume for a specific stratum required a further computational step. The use of PPS sampling, described earlier, results in the CF/AC volume of each unit having equal weight. The estimate for each stratum, therefore, is the arithmetic average of all units in the stratum. This is represented by:

$$\text{CF/AC}_j = \frac{\sum_{i=1}^n a_{ij}}{n};$$

where:

a_{ij} = per-acre residue volume for i^{th} sample in j^{th} stratum, and

n = number of sample units in j^{th} stratum.

The CF/MBF ratio for a stratum is similarly computed, using a ratio of the means approach. The formula for computing the ratio for a specific stratum ratio is represented by:

$$\text{Ratio}_j = \frac{\frac{\sum_{i=1}^n a_{ij}}{n}}{\frac{\sum_{i=1}^n h_{ij}}{n}};$$

where:

a_{ij} and n are as defined above for CF/AC_j, and

h_{ij} = per-acre harvest volume for i^{th} sample unit in j^{th} stratum.

Computing the volume for characterization of residue is based on subsample measurements. The volume of each subsample piece is the same as that used for estimating the volume of the unit (CF/AC).

The gross volume of all pieces was summarized by small-end and large-end diameter and length classes for each cutover area. A proportion was developed to relate the accumulated subsample volume to the total volume estimated from the line transects. This proportion was then used to adjust the subsample volume in each diameter/length class to reflect the computed residue volume for each cutover area. To obtain the number of pieces per acre by diameter/length class, the adjusted volume for each class was then divided by the average piece volume for the class.

Net chippable volume for residue characterization was computed using item 5 of the subsample measurements.

Stratum averages of residue characteristics were computed in a manner similar to that described above. In effect, residue characteristics were developed using all subsample pieces in each stratum and the average volume estimate for that stratum.

Ratios for estimating logging residue volume are presented in two forms. One ratio relates the cubic-foot volume of residue to 1,000 board feet of timber harvested (CF/MBF). The other gives residue volume in terms of cubic feet per acre (CF/AC). Both ratios have value, depending upon the user's need and the availability of supporting data. Estimates of residue volume are obtained by applying the appropriate ratio to timber harvest volume or acreage for each stratum within the geographic area to be assessed.

A wide range of potential uses can be made of the tables, which show gross and net volumes of residue, with and without bark; softwoods and hardwoods; and live versus dead/cull material. Conversions for metric values are on page 40, and wood density and heating values for selected species are shown in appendix 1. Selected tables from similar studies conducted in Idaho, Montana, Oregon, and Washington are in appendix 2 and are included to aid in regional assessments of residue volume across the five-State area.

It is especially important to understand that estimates based on data from this report indicate only the existence of residue material. The availability of materials for conversion to energy, pulp, or other products depends on a wide range of factors, such as competing uses, intent of the landowners, environmental concerns, and cost. Many other factors influence the accumulation of residue but are beyond the scope of this report. Ultimately, it is the responsibility of analysts to determine the volume of residue that can be considered physically and economically available.

Ratios of residue volume to harvest volume.—Table 1 presents the ratios of residue volume to harvest volume for gross and net volume of logging residue, with and without bark, for each of the study strata. Net volume represents the chippable portion of the residue, or that considered usable for fiber-based products. A variety of defects, such as cracks, checks, or early stages of rot, make much of this material unusable for solid wood products. Whatever product is considered, it should be recognized that some unusable material has to be removed to recover the desired portions.

Study Results

Residue Volume Estimators



Table 1—Average gross and net volume ratios of logging residue, per thousand board feet of harvest, by wood only and by wood and bark, by stratum

Stratum	Wood		Wood and bark	
	Gross	Net	Gross	Net
<u>Cubic feet per thousand board feet</u>				
Coastal:				
Public--				
Clearcut	77	53	92	68
Partial cut	94	53	112	71
Private--				
Clearcut	56	40	67	50
Partial cut	89	56	106	72
Interior:				
Public--				
Clearcut	53	36	64	47
Partial cut	101	59	121	79
Private ^{1/}	87	55	104	72
Ponderosa pine ^{2/}	108	61	129	83

^{1/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{2/}Samples were selected from all harvest methods and ownership classes.

Gross volume represents the bulk or mass of logging residue, based on external dimensions. This measurement includes space not occupied by wood fiber, such as hollow logs (fig. 7) and pieces with splinters or chunks missing. Gross volume also includes material too rotten to have product value. The extreme example is a piece with gross volume but no chippable material.

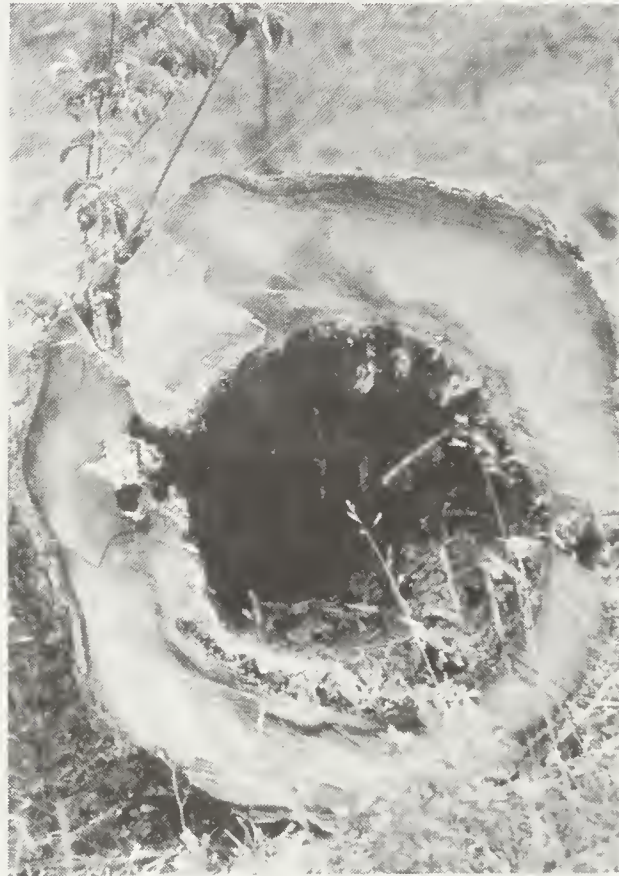


Figure 7.—Hollow logs have a gross volume, represented by external dimensions, that includes space containing no usable wood fiber.

Gross volume is important to measure because it represents material that has to be removed or otherwise treated to reduce its impact on the site. Residue has impacts on reforestation, esthetics, environmental quality, wildlife habitat, stand management activities, and fire hazard. Given these relationships, a measure of gross residue volume is important in the broad context of residue management.

Estimates of gross volume of residue are also important for determining equipment requirements and the cost of handling and transporting residue. Although the net volume of residue represents product quantity and value, it is the gross volume that must be handled to recover the usable portions.

The volume of residue for a specific area can be estimated using timber harvest data for the area and ratios available in table 1. A separate ratio and timber harvest figure should be used for each stratum represented in the geographic area for which residue assessments are being made. These ratios, and other data in this report, are representative of current harvesting practices and markets and should remain useful as long as harvesting technology, stand conditions, and the current product mix do not change significantly.

The gross volume estimates in table 1 show the ratios for partial-cut areas to be higher than for clearcut areas. With the exception of public lands in the coastal zone, the same relation holds true for net volume ratios. The reason is that most partial cutting is oriented to a specific product or tree class. Thus, material not sought is frequently not removed (previously dead and cull material, for example). In clearcutting, however, nearly all trees are cut, thereby exposing all timber to the possibility of removal based on marginal product value of each piece. The result is a higher volume of residue in relation to timber volume removed (harvest) for partial cuts.

As seen in the following tabulation, the percentage of net volume to gross volume is higher for clearcuts than for partial-cut strata, or areas that are predominantly partial-cut harvested. Material that was dead or cull prior to harvest usually has more defect than green timber. As noted above, dead or cull material is more likely to be removed from clearcut areas than from partial-cut areas. Therefore, the average amount of defect is lower for clearcut areas and is represented by a higher net-to-gross percentage.

The following tabulation compares the net volume of residue to gross volume for each stratum.

<u>Stratum</u>	<u>Net volume as a percentage of gross volume (wood only)</u>
Coastal:	
Public—	
Clearcut	69
Partial cut	56
Private—	
Clearcut	71
Partial cut	63
Interior:	
Public—	
Clearcut	68
Partial cut	58
Private	63
Ponderosa pine	56

Ratios of residue volume to area harvested.—Ratios of cubic feet of residue to acres harvested are valuable expressions of the quantity of logging residue. Per-acre volume is especially useful for making economic assessments and for evaluating residue management alternatives. Table 2 gives the average gross and net residue volume per acre, by stratum, for wood only and for wood and bark. These data can be used to estimate residue volume when the number of acres harvested is known for a given stratum.

Table 2—Average gross and net per acre volume of logging residue, by wood only and by wood and bark, by stratum

Stratum	Wood		Wood and bark	
	Gross	Net	Gross	Net
<u>Cubic feet per acre</u>				
Coastal:				
Public--				
Clearcut	2,216	1,516	2,636	1,936
Partial cut	1,651	935	1,936	1,246
Private--				
Clearcut	2,483	1,767	2,935	2,219
Partial cut	2,227	1,392	2,639	1,804
Interior:				
Public--				
Clearcut	1,217	825	1,453	1,061
Partial cut	1,578	917	1,896	1,235
Private ^{1/}	1,527	963	1,827	1,262
Ponderosa pine ^{2/}	1,232	702	1,475	945

^{1/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{2/}Samples were selected from all harvest methods and ownership classes.

The information in table 2 can be used to compare relative densities of residue among strata to aid in setting priorities for utilization or treatment options. Greater concentrations of residue are, for example, generally more feasible to recover than are small quantities. Thus, use of the above data would help to identify broad acreage groupings that have the greatest potential.

Comparison of these data to a previous statewide study (Howard 1973) shows a rather large change in average net residue volume. The data from these two studies are not directly comparable, however, because of differences in measurement standards. Differences associated with standard errors may also contribute to the apparent differences in reported volumes. In addition, the 1973 study did not use the same basis for stratification as did the current study. The most comparable figures between the two studies are for the coastal area. Average net volume of residue for coastal area clearcuts was estimated to be about 2,755 cubic feet per acre in the 1973 report. For this study average net volume for clearcuts is 1,516 and 1,767 cubic feet per acre for public and private lands, respectively. The 1973 figure should be slightly higher as that study used larger measurement standards for residue material.

Further breakdown of per acre residue volumes is given in table 3. These data show live and dead or cull volume separately for softwoods and hardwoods. Two special characteristics of the data in table 3 should be noted. First, these figures do not include residue volume in large piles. By comparison, figures in table 2 include pile volume. Secondly, these data are based on a subsample of transect residue pieces, as described earlier. Being a subsample, the distribution by species or by live versus dead or cull are likely to differ from the distribution observed for the transect volume. A comparison of the actual figures shows a discrepancy of only 0 to 10 cubic feet per acre for the eight strata.

Table 3—Average gross and net volume of logging residue^{1/} (wood only) by species and by live or dead/cull material,^{2/} by stratum

Stratum	Softwood				Hardwood			
	Gross		Net		Gross		Net	
	Live	Dead or cull	Live	Dead or cull	Live	Dead or cull	Live	Dead or cull
Cubic feet per acre								
Coastal:								
Public--								
Clearcut	558	1,135	490	667	162	55	160	34
Partial cut	301	1,067	263	492	39	90	36	60
Private--								
Clearcut	739	1,307	649	730	316	72	305	56
Partial cut	510	1,431	448	711	148	102	141	73
Interior:								
Public--								
Clearcut	358	716	331	408	28	14	22	9
Partial cut	323	1,107	275	555	5	16	5	13
Private ^{3/}	434	932	401	459	29	27	28	17
Ponderosa pine ^{4/}	251	897	233	423	0	1	0	0

^{1/}Does not include residue in large piles.

^{2/}Breakdown of live versus dead or cull is based on subsamples of all residue pieces; the sum of these two values therefore may not equal total residue values shown in other tables.

^{3/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{4/}Samples were selected from all harvest methods and ownership classes.

Residue from hardwoods is a significant component of the total residue picture in California. The data in table 3 show that hardwoods comprise from almost 9 percent to over 20 percent of total residue volume for the coastal area. In the interior, where hardwoods are less predominant, the range is from almost none to 5 percent of total residue volume. Most of the current timber harvest is from softwoods. Hardwoods occur as a minor component in many of the stands being harvested. Because hardwoods are not the desired species they tend to be cut and left as residue; this is particularly true for clearcuts. This situation is borne out by the data in table 3. Examination of the coastal area, where most of the hardwoods occur, show the average live (when cut) volume for hardwoods at about 68 percent and ranging as high as 84 percent. Live softwood volume, on the other hand, averages only 41 percent, with the highest value at 47 percent. Further examination of the data show hardwood residue in the coastal area to be about 86 percent sound; softwoods average only 63 percent sound. Hardwoods thus have a higher fiber recovery ratio than do softwoods.

Special relationships.—Tables 4 and 5 provide additional insight into the residue situation in California. These data show the percent of residue that was dead or cull at the time of harvest and the percent of volume in large piles.

As noted earlier, the percent of residue volume made up of previously dead or cull material is higher on partial-cut areas than on clearcuts. This is borne out by information in table 4 which shows 70 to 77 percent of gross residue volume for partial-cut areas was from trees that were dead or cull at the time of harvest. For net volume the percentage was somewhat lower. This is explained by the fact that dead/cull material has more defect than does green timber and thus accounts for a lower proportion of the chippable volume of residue.

These data are especially useful in projecting timber inventories. Material that was dead or cull before harvest has been accounted for by mortality and defect figures in current inventory data. Thus, the portion of logging residue from live trees needs to be deducted to complete the estimate of inventory drain.

The data in table 5 show the relative contribution of the volume in large residue piles to overall stratum averages. In the coastal area the percent of residue in large piles is substantially higher on public lands than on private lands. This difference is not seen in the interior. For comparable strata, the observed figures for California are higher than those reported for Oregon and Washington. An explanation of these differences is beyond the scope of this report. The differences emphasize the need to ascertain timber sales policies when studying the feasibility of using residue.

Table 4—Dead and cull material (wood only) as a percentage of average gross and net residue volume, by stratum

Stratum	Gross volume	Net volume
	<u>Percent of dead and cull</u>	
Coastal:		
Public--		
Clearcut	62	52
Partial cut	77	65
Private--		
Clearcut	57	45
Partial cut	70	57
Interior:		
Public--		
Clearcut	65	54
Partial cut	77	67
Private ^{1/}	67	53
Ponderosa pine ^{2/}	78	64

^{1/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{2/}Samples were selected from all harvest methods and ownership classes.

Table 5—Volume of residue in large piles as a percentage of gross and net volume (wood only), by stratum

Stratum	Gross volume		Net volume	
	Average	Highest	Average	Highest
	<u>Percent</u>			
Coastal:				
Public--				
Clearcut	14	65	11	56
Partial cut	9	46	9	48
Private--				
Clearcut	2	15	1	13
Partial cut	2	28	1	29
Interior:				
Public--				
Clearcut	8	78	7	74
Partial cut	8	42	7	36
Private ^{1/}	7	56	6	45
Ponderosa pine ^{2/}	7	19	6	21

^{1/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{2/}Samples were selected from all harvest methods and ownership classes.

Residue Characteristics

Tables 6 through 9 concern only residue that is scattered throughout the areas sampled (transect volume) and do not include residue in large piles. Table 10 pertains to distribution of all residue including that in large piles. Additional tables in the appendix provide similar data that indicate whether the material was from softwoods or hardwoods and whether it was live or dead/cull at the time of harvest; these data are given by small-end and large-end diameter classes.

Table 6—Gross volume (wood only) of logging residue, by small-end diameter and length classes, by stratum^{1/}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	42	46	29	79	67	32	297
	4.0-4.9	40	23	14	40	21	6	146
	5.0-5.9	6	5	3	8	7	1	32
	6.0-6.9	31	19	11	46	18	9	135
	7.0-7.9	3	2	3	4	4	0	16
	8.0-11.9	43	52	31	72	49	31	280
	12.0-15.9	28	16	26	106	26	30	234
	16.0-19.9	32	21	33	73	46	10	217
	20.0-27.9	33	36	69	67	77	48	333
	28.0+	27	24	0	45	103	13	214
Total		288	247	223	545	422	183	1,910
Partial cut	3.1-3.9	31	23	23	50	34	23	186
	4.0-4.9	35	22	13	41	17	6	136
	5.0-5.9	4	3	2	9	6	1	29
	6.0-6.9	23	17	13	31	19	6	110
	7.0-7.9	1	0	1	4	1	0	10
	8.0-11.9	29	22	30	70	67	10	229
	12.0-15.9	30	19	14	38	57	45	207
	16.0-19.9	20	27	24	39	40	59	211
	20.0-27.9	7	18	5	41	30	39	142
	28.0+	49	0	0	88	38	57	234
Total		235	154	128	416	311	251	1,497
Private--								
Clearcut	3.1-3.9	24	35	28	82	80	38	290
	4.0-4.9	22	21	16	47	54	21	183
	5.0-5.9	4	3	5	13	10	3	40
	6.0-6.9	19	15	14	69	45	17	181
	7.0-7.9	1	5	2	4	3	1	19
	8.0-11.9	24	40	42	91	78	16	293
	12.0-15.9	19	19	38	86	58	17	239
	16.0-19.9	9	34	26	86	54	12	223
	20.0-27.9	31	54	25	92	95	72	371
	28.0+	8	0	17	181	225	159	591
Total		165	230	218	755	706	359	2,435
Partial cut	3.1-3.9	15	14	14	48	41	14	147
	4.0-4.9	20	20	13	44	28	12	141
	5.0-5.9	2	3	3	10	3	1	24
	6.0-6.9	11	15	13	53	27	5	127
	7.0-7.9	0	1	1	2	3	0	9
	8.0-11.9	27	38	28	94	56	19	265
	12.0-15.9	16	27	19	70	48	9	191
	16.0-19.9	11	31	33	109	80	37	303
	20.0-27.9	18	24	1	100	98	45	292
	28.0+	0	0	116	220	215	136	688
Total		126	177	247	756	602	281	2,192

See footnotes at end of table.

Table 6—Gross volume (wood only) of logging residue, by small-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
Interior: Public--	Inches	Cubic feet per acre						
Clearcut	3.1-3.9	26	20	11	41	30	6	136
	4.0-4.9	26	12	13	34	14	6	107
	5.0-5.9	1	3	1	5	3	0	17
	6.0-6.9	18	19	14	26	11	8	98
	7.0-7.9	0	1	1	4	0	0	8
	8.0-11.9	25	23	15	62	29	14	170
	12.0-15.9	14	8	32	54	22	17	149
	16.0-19.9	6	9	27	30	43	0	117
	20.0-27.9	11	9	8	26	53	7	118
	28.0+	0	0	0	21	101	69	192
Total		130	108	125	309	312	130	1,117
Partial cut	3.1-3.9	32	26	19	44	20	10	152
	4.0-4.9	29	18	10	25	14	5	103
	5.0-5.9	3	3	3	4	3	2	22
	6.0-6.9	18	14	11	25	14	7	91
	7.0-7.9	0	3	3	0	0	0	8
	8.0-11.9	24	26	15	45	36	21	168
	12.0-15.9	25	7	18	50	39	24	166
	16.0-19.9	14	25	14	47	28	19	149
	20.0-27.9	12	6	11	46	78	54	210
	28.0+	15	31	15	117	64	133	378
Total		177	163	124	408	299	279	1,452
Private ^{2/}	3.1-3.9	27	23	15	38	34	12	151
	4.0-4.9	25	17	14	30	27	6	121
	5.0-5.9	2	5	4	7	8	2	29
	6.0-6.9	21	17	15	33	28	15	132
	7.0-7.9	2	2	4	11	5	0	26
	8.0-11.9	28	23	30	69	38	17	207
	12.0-15.9	15	16	15	40	46	20	156
	16.0-19.9	25	10	12	59	44	28	181
	20.0-27.9	20	14	28	65	51	38	218
	28.0+	11	7	0	42	64	71	196
Total		180	139	140	397	350	213	1,422
Ponderosa pine ^{3/}	3.1-3.9	29	21	12	32	28	11	136
	4.0-4.9	20	10	5	19	6	3	65
	5.0-5.9	3	2	2	2	2	0	12
	6.0-6.9	10	8	6	16	10	14	68
	7.0-7.9	2	2	0	1	0	0	7
	8.0-11.9	28	40	11	56	36	32	206
	12.0-15.9	9	11	15	57	38	20	153
	16.0-19.9	12	7	20	66	43	45	196
	20.0-27.9	15	20	17	57	101	39	252
	28.0+	0	0	0	8	20	20	49
Total		132	126	93	320	288	187	1,149

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 7—Net volume (wood only) of logging residue, by small-end diameter and length classes, by stratum^{1/}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	36	38	26	75	64	30	272
	4.0-4.9	28	20	13	31	20	6	120
	5.0-5.9	5	4	3	7	7	1	23
	6.0-6.9	22	15	9	34	15	8	106
	7.0-7.9	2	2	2	3	2	0	13
	8.0-11.9	25	31	21	52	39	21	193
	12.0-15.9	19	9	23	72	18	19	162
	16.0-19.9	14	6	17	42	31	7	119
	20.0-27.9	20	32	46	33	48	24	206
	28.0+	27	11	0	25	54	9	128
Total		203	172	163	378	303	129	1,351
Partial cut	3.1-3.9	22	18	18	40	26	18	145
	4.0-4.9	22	16	8	31	12	3	94
	5.0-5.9	2	2	2	8	5	1	23
	6.0-6.9	11	10	9	23	10	5	70
	7.0-7.9	1	0	1	3	1	0	8
	8.0-11.9	14	8	17	42	29	7	119
	12.0-15.9	16	8	3	17	23	36	104
	16.0-19.9	13	13	18	23	18	27	114
	20.0-27.9	5	2	1	12	8	17	48
	28.0+	17	0	0	41	27	34	122
Total		128	80	81	244	165	151	851
Private--								
Clearcut	3.1-3.9	19	29	25	75	73	36	265
	4.0-4.9	16	16	14	41	51	20	160
	5.0-5.9	2	2	4	12	10	3	35
	6.0-6.9	14	11	10	53	41	17	149
	7.0-7.9	0	4	1	4	2	1	15
	8.0-11.9	13	28	28	76	63	13	223
	12.0-15.9	11	12	26	53	42	15	162
	16.0-19.9	7	22	17	62	37	5	153
	20.0-27.9	19	32	14	52	43	50	212
	28.0+	4	0	15	101	127	113	362
Total		109	161	160	533	498	277	1,741
Partial cut	3.1-3.9	12	11	12	43	37	13	130
	4.0-4.9	13	15	10	38	24	11	113
	5.0-5.9	2	3	2	9	3	1	22
	6.0-6.9	8	11	9	35	23	5	93
	7.0-7.9	0	1	1	1	2	0	7
	8.0-11.9	17	23	20	57	38	16	174
	12.0-15.9	13	15	7	40	34	5	116
	16.0-19.9	5	12	18	57	46	29	169
	20.0-27.9	6	11	1	50	51	26	148
	28.0+	0	0	56	131	128	81	397
Total		78	107	140	466	390	190	1,373

See footnotes at end of table.

Table 7—Net volume (wood only) of logging residue, by small-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Interior: Public-- Clearcut	3.1-3.9	22	19	11	41	31	6	133
	4.0-4.9	20	11	12	32	13	5	94
	5.0-5.9	2	3	1	5	2	0	15
	6.0-6.9	13	14	10	23	10	6	79
	7.0-7.9	0	1	1	3	0	0	6
	8.0-11.9	14	15	10	44	19	11	116
	12.0-15.9	9	5	19	29	12	14	90
	16.0-19.9	3	3	13	16	26	0	63
	20.0-27.9	9	4	9	15	28	3	70
	28.0+	0	0	0	11	48	39	99
Total		94	78	90	223	193	89	770
Partial cut	3.1-3.9	28	24	18	40	20	9	139
	4.0-4.9	23	15	9	21	12	3	85
	5.0-5.9	3	3	3	4	2	1	19
	6.0-6.9	12	10	8	19	10	5	66
	7.0-7.9	0	2	2	0	0	0	6
	8.0-11.9	15	17	10	32	20	16	113
	12.0-15.9	15	0	16	30	10	13	86
	16.0-19.9	7	13	5	24	13	3	67
	20.0-27.9	6	5	6	7	35	25	85
	28.0+	16	27	6	47	17	64	178
Total		127	120	86	228	143	142	849
Private ^{2/}	3.1-3.9	21	21	13	32	29	11	130
	4.0-4.9	16	12	11	24	22	5	92
	5.0-5.9	1	4	3	6	7	2	26
	6.0-6.9	12	12	12	24	21	14	96
	7.0-7.9	2	2	3	10	4	0	22
	8.0-11.9	16	12	15	46	29	13	133
	12.0-15.9	12	10	10	24	27	9	94
	16.0-19.9	10	4	8	26	25	18	93
	20.0-27.9	19	5	17	30	23	20	116
	28.0+	6	4	0	19	23	44	98
Total		120	90	98	244	213	138	906
Ponderosa pine ^{3/}	3.1-3.9	23	19	11	26	28	7	116
	4.0-4.9	13	8	4	13	6	2	48
	5.0-5.9	2	2	2	2	1	0	11
	6.0-6.9	4	5	5	10	7	12	48
	7.0-7.9	1	2	0	1	0	0	7
	8.0-11.9	16	24	10	36	22	21	132
	12.0-15.9	6	5	10	23	22	8	78
	16.0-19.9	5	2	12	18	26	20	86
	20.0-27.9	13	8	9	29	30	20	112
	28.0+	0	0	0	2	4	7	14
Total		88	79	68	166	152	102	657

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 8—Gross and net volume (wood only) of logging residue, by percent of chippable material, by stratum^{1/}

		Chippable material (percent)							
Stratum	Volume	0	1-20	21-40	41-60	61-80	81-99	100	Total
<u>Cubic feet per acre</u>									
Coastal:									
Public--									
Clearcut	Gross	38	139	256	241	232	271	609	1,911
	Net	0	14	77	120	162	243	609	1,351
Partial cut	Gross	136	206	197	222	198	156	311	1,497
	Net	0	21	59	111	139	141	311	852
Private--									
Clearcut	Gross	35	166	249	414	328	308	842	2,435
	Net	0	17	75	207	230	277	842	1,741
Partial cut	Gross	113	234	293	346	286	318	549	2,193
	Net	0	23	88	173	200	287	549	1,374
Interior:									
Public--									
Clearcut	Gross	30	87	152	162	120	155	343	1,118
	Net	0	9	45	81	84	139	343	771
Partial cut	Gross	76	182	235	260	181	133	258	1,452
	Net	0	18	71	130	127	120	258	849
Private ^{2/}	Gross	81	170	189	185	145	143	435	1,423
	Net	0	17	57	92	101	129	435	906
Ponderosa pine ^{3/}	Gross	79	212	157	137	111	104	267	1,150
	Net	0	21	47	69	78	93	267	658

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 9—Number of pieces of logging residue per acre, by small-end diameter and length classes, by stratum^{1/}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
		Number of pieces per acre						
	Inches	-	-	-	-	-	-	-
Coastal:								
Public--								
Clearcut	3.1-3.9	41.8	39.0	25.9	58.3	32.3	10.9	208.2
	4.0-4.9	31.9	18.2	10.3	19.7	7.5	1.9	89.5
	5.0-5.9	2.8	2.4	1.5	3.9	1.7	.2	12.6
	6.0-6.9	12.2	6.0	3.6	12.4	4.5	1.5	40.1
	7.0-7.9	.9	.6	.6	.9	.8	0	3.8
	8.0-11.9	8.3	6.4	4.7	1.1	5.4	2.4	37.3
	12.0-15.9	2.4	1.3	2.4	7.3	2.1	.9	16.5
	16.0-19.9	1.7	1.1	1.3	3.9	2.3	.4	10.7
	20.0-27.9	1.1	1.1	1.9	2.1	1.9	.9	9.0
	28.0+	.4	.4	0	.6	1.3	.2	2.8
Total		103.5	76.5	52.1	119.3	59.7	19.3	430.5
Partial cut	3.1-3.9	28.8	22.0	2.9	39.4	22.2	6.2	139.4
	4.0-4.9	27.5	17.5	9.4	22.6	7.9	1.7	86.6
	5.0-5.9	2.1	1.5	1.3	3.6	1.7	.4	10.7
	6.0-6.9	7.2	6.6	4.9	1.2	3.8	.9	33.7
	7.0-7.9	.4	0	.4	1.1	.4	.2	2.6
	8.0-11.9	6.0	3.4	4.5	11.7	7.7	.9	34.1
	12.0-15.9	3.0	1.7	1.5	3.4	3.8	1.7	15.1
	16.0-19.9	1.1	1.5	1.3	1.9	1.9	1.7	9.4
	20.0-27.9	.2	.6	.2	1.3	.9	.6	3.8
	28.0+	.4	0	0	1.1	.4	.6	2.6
Total		76.7	54.8	44.3	96.4	50.7	14.9	337.9
Private--								
Clearcut	3.1-3.9	21.7	27.7	23.5	63.4	42.6	13.4	192.4
	4.0-4.9	19.4	13.6	10.4	29.5	23.5	3.4	99.8
	5.0-5.9	1.6	1.8	1.9	5.1	2.6	.7	13.8
	6.0-6.9	7.9	5.1	4.6	17.1	9.7	2.6	47.2
	7.0-7.9	.4	1.4	.5	1.2	.9	.2	4.6
	8.0-11.9	4.8	7.2	7.2	14.8	9.5	1.9	45.6
	12.0-15.9	1.9	1.4	2.8	6.5	4.2	.9	17.8
	16.0-19.9	.5	1.8	1.4	3.9	2.3	.5	10.4
	20.0-27.9	1.1	1.6	.7	2.6	2.8	1.9	10.8
	28.0+	.2	0	.2	2.1	2.5	1.6	6.5
Total		59.5	61.7	53.4	146.5	100.7	27.2	448.9
Partial cut	3.1-3.9	13.5	13.7	13.0	37.4	22.4	4.8	104.8
	4.0-4.9	16.0	15.0	8.9	23.7	11.9	2.3	77.8
	5.0-5.9	1.3	1.6	1.6	4.3	1.0	.2	10.1
	6.0-6.9	4.8	5.9	4.3	12.5	5.6	1.2	34.3
	7.0-7.9	0	.5	.3	.7	.5	0	2.0
	8.0-11.9	5.8	6.9	4.6	12.7	6.3	2.3	38.6
	12.0-15.9	1.6	2.5	1.3	5.6	3.5	.7	15.2
	16.0-19.9	.7	1.6	1.8	5.3	3.1	1.2	13.7
	20.0-27.9	.7	.7	.2	3.0	2.8	.8	8.1
	28.0+	0	0	1.3	3.0	2.5	1.2	7.9
Total		44.3	48.5	37.4	108.1	59.5	14.5	312.3

See footnotes at end of table.

Table 9—Number of pieces of logging residue per acre, by small-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	25.0	18.2	11.1	32.0	15.7	1.4	103.4
	4.0-4.9	20.7	9.3	7.7	17.5	5.5	1.1	61.8
	5.0-5.9	.7	1.4	.7	2.7	1.3	.2	7.0
	6.0-6.9	7.1	5.9	4.5	8.4	2.9	1.1	29.8
	7.0-7.9	0	.4	.4	.5	.2	0	1.4
	8.0-11.9	4.6	3.9	2.1	7.5	2.5	1.1	21.8
	12.0-15.9	1.3	.5	2.5	4.3	1.6	.5	10.7
	16.0-19.9	.4	.5	1.3	1.3	2.0	0	5.4
	20.0-27.9	.4	.4	.4	.9	1.4	.2	3.6
28.0+	0	0	0	.4	1.4	.9	2.7	
Total		60.2	40.5	30.5	75.4	34.5	6.4	247.6
Partial cut	3.1-3.9	32.2	25.0	18.7	36.5	12.5	1.8	126.5
	4.0-4.9	25.2	12.5	7.0	12.5	5.7	1.4	64.2
	5.0-5.9	1.8	1.9	1.6	1.9	.4	.2	7.8
	6.0-6.9	7.2	4.9	3.9	6.8	2.3	1.0	26.1
	7.0-7.9	.2	.8	1.0	.2	0	0	2.1
	8.0-11.9	4.7	4.3	2.9	7.8	3.9	1.4	25.0
	12.0-15.9	2.1	.8	1.4	3.9	2.3	.8	11.3
	16.0-19.9	.8	1.4	.8	2.5	1.4	.8	7.6
	20.0-27.9	.2	.2	.4	1.4	2.1	1.4	5.7
28.0+	.2	.4	.2	1.6	.6	1.4	4.3	
Total		74.5	52.1	37.8	75.1	31.2	9.9	280.6
Private ^{2/}								
	3.1-3.9	25.6	23.1	13.7	33.2	19.0	3.8	118.4
	4.0-4.9	20.8	12.8	9.2	18.0	9.9	1.5	72.1
	5.0-5.9	1.2	2.3	1.7	3.2	2.6	.4	11.5
	6.0-6.9	8.7	6.5	5.5	9.3	6.8	1.7	38.7
	7.0-7.9	.7	.9	1.0	2.8	1.0	0	6.4
	8.0-11.9	5.8	4.4	5.1	10.5	5.2	1.6	32.6
	12.0-15.9	1.3	1.5	1.3	3.5	2.9	.7	11.2
	16.0-19.9	1.3	.6	.7	2.9	1.9	1.2	8.6
	20.0-27.9	.6	.4	.9	1.7	1.5	.9	6.0
28.0+	.1	.1	0	.7	.9	.7	2.6	
Total		66.2	52.6	39.1	85.8	51.8	12.5	308.0
Ponderosa pine ^{3/}								
	3.1-3.9	27.6	16.2	11.2	20.6	13.0	2.2	90.8
	4.0-4.9	16.8	8.3	4.0	8.1	1.9	.5	39.5
	5.0-5.9	1.4	.9	1.0	1.0	.5	0	4.8
	6.0-6.9	4.3	3.1	1.7	5.0	2.8	1.2	18.1
	7.0-7.9	.5	.7	.2	.3	.2	0	1.9
	8.0-11.9	5.5	5.7	2.1	8.8	3.6	1.9	27.6
	12.0-15.9	.9	1.0	1.6	4.1	2.2	.5	10.4
	16.0-19.9	.7	.3	1.0	2.9	1.7	1.7	8.5
	20.0-27.9	.5	.5	.5	1.9	2.4	1.0	6.9
28.0+	0	0	0	.2	.3	.3	.9	
Total		58.2	36.8	23.3	53.0	28.7	9.5	209.5

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 10—Distribution of logging residue by slope and distance to road classes, by stratum^{1/}

Stratum	Slope	Distance to road (feet)			
		0-500	501-1,000	1,100	Total
		<u>Percent</u>			
Coastal:					
Public-- Clearcut	0-35	33.9	7.2	0.3	41.4
	36+	45.2	12.4	1.0	58.6
Total		79.1	19.6	1.3	100.0
Partial cut	0-35	50.8	5.2	0	56.0
	36+	31.2	8.8	4.0	44.0
Total		82.0	14.0	4.0	100.0
Private-- Clearcut	0-35	24.4	4.1	.2	28.7
	36+	62.2	8.9	.2	71.3
Total		86.6	13.0	.4	100.0
Partial cut	0-35	41.5	7.2	.3	49.0
	36+	36.2	14.5	.3	51.0
Total		77.7	21.7	.6	100.0
Interior:					
Public-- Clearcut	0-35	56.2	13.2	0	69.4
	36+	28.0	2.6	0	30.6
Total		84.2	15.8	0	100.0
Partial cut	0-35	46.8	24.4	4.8	76.0
	36+	13.4	10.1	.5	24.0
Total		60.2	34.5	5.3	100.0
Private ^{2/}	0-35	60.3	15.7	.6	76.6
	36+	17.0	4.3	2.1	23.4
Total		77.3	20.0	2.7	100.0
Ponderosa pine ^{3/}					
	0-35	60.6	20.0	2.6	83.2
	36+	10.2	4.2	2.4	16.8
Total		70.8	24.2	5.0	100.0

^{1/}Includes residue in large piles that were usually, but not always, adjacent to a road.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Volume by diameter and length classes.—Tables 6 and 7 give the distribution of gross and net residue volume (wood only) for each of the study strata. The gross volume table represents material that must be handled, whether for product recovery or for treatment. Net volume represents the chippable content of residue. Even if product recovery is the major objective, gross volume is an important consideration.

The data are reported here in cubic feet per acre because feasibility studies usually involve per-acre figures. In some situations it may be desirable to relate residue characteristics to cubic feet per 1,000 board feet of harvest volume. This can be accomplished by determining the desired relationship of gross or net volume from these tables and applying it to CF/MBF volume estimates on a percentage basis.

The data in tables 6 and 7 can be used to determine the relation between gross and net residue volume for any size class or the proportion of residue above or below a certain utilization standard. The following tabulation compares, for example, gross and net volume for two size categories on public clearcuts in California:

<u>Diameter/length class</u>	<u>Residue volume</u>	
	<u>Gross</u>	<u>Net</u>
	— (CF/AC) —	
Diameter: 3.1-3.9 inches Length: 8.0-15.9 feet	79	75
Diameter: 16.0-19.9 inches Length: 8.0-15.9 feet	73	42

In this example nearly all the gross volume (95 percent) in the smaller diameter class (3.1 to 3.9 inches) is sound. But in the larger diameter class only 42 cubic feet, or 58 percent, of the gross volume is chippable. This type of information is critical in evaluating the net fiber cost when assessing utilization of residue materials. Similar comparisons can be made for large-end diameter classes by using tables 19 and 20 in the appendix.

Tables 13 through 23 in the appendix provide additional data on the portion of residue that was from softwoods or hardwoods or was live or dead/cull at the time of harvest. This information may be especially significant if product options differ by species or for green versus dead/cull material. These tables also provide some of the same classifications of residue by large-end diameter classes.

Percent chippable.—The suitability of logging residue for a given product usually depends on physical characteristics of the material. A key factor is the nature and amount of defect acceptable for a given type of product. Checking and splitting, for example, make wood less suitable for sawn products but have no effect on the quantity or quality of wood chips. Likewise, decay beyond the very early stages may prohibit use for pulp but not necessarily for energy.

Assessment of the cost and returns of converting residue into a particular product requires that the acceptable level of defect be defined. Material that does not meet this standard is rejected as having too little usable content to justify the cost of handling and processing. The data presented in table 8 can be used to make these broad types of evaluations. Gross and net volume of scattered residue are given for seven classes of chippability. The data in tables 6 and 7 can be used to further refine estimates of residue volume that can be considered economically available.

Following is an example of how to interpret the data in table 8. In the interior private stratum gross volume of residue in the 61- to 80-percent chippable class is 145 cubic feet per acre. Net volume for this class is 101 cubic feet per acre. Thus, 145 cubic feet would have to be processed to recover 101 cubic feet of usable wood fiber. This net volume indicated above is not synonymous with recovery of solid wood products because defects, such as cracks, splits, and early stages of decay, greatly reduce use for these products. Therefore, the data in table 8 cannot be used to make precise assessments of solid product potential.

Number of pieces per acre.—The cost of retrieving residue material is a critical factor in decisions about utilization. Because equipment needs and costs of handling residue vary considerably, it is necessary to know the number of pieces and the volume by size classes (see table 9). Tables 24 and 30 in the appendix show number of pieces per acre by species, by live versus dead or cull, and for small-end and large-end diameter classes.

Because the data in table 9 are averages for each stratum, the tabulations include fractions of pieces. In actuality, certain diameter or length classes may be represented on specific cutover areas, but not on others. This is particularly true for the larger size classes. What is important, however, is whether there are few or many pieces of a given size.

Volume per piece may be important in some assessments of logging residue. Tables 6 and 9 can be used to estimate the average gross volume per piece by dividing the volume of residue in a specific diameter and length class by the number of pieces in that class. For example, table 6 shows that in the interior private stratum, pieces 3.1 to 3.9 inches in diameter and 16.0 to 31.9 feet long have a gross volume of 34 cubic feet per acre. Table 9 shows that for the same size class there are 19.0 pieces per acre. Therefore, the average volume per piece is about 1.79 cubic feet. Table 7 can be used to find the net volume per piece in a similar fashion.

An interesting comparison between volume per acre and number of pieces per acre can be made by using data from tables 6 and 9. The tabulation below compares the gross volume (table 6) of residue less than 6 inches in diameter with the number of pieces (table 9) less than 6 inches in diameter.

<u>Stratum</u>	<u>Residue less than 6 inches in diameter</u>	
	<u>As a percent</u> <u>of gross volume</u>	<u>As a percent of all</u> <u>pieces per acre</u>
	----- (Percent) -----	
Coastal:		
Public—		
Clearcut	28	72
Partial cut	26	70
Private—		
Clearcut	16	68
Partial cut	14	62
Interior:		
Public—		
Clearcut	21	70
Partial cut	23	71
Private	22	66
Ponderosa pine	22	64

These results show that although the number of pieces of residue less than 6 inches is quite high, the volume in these pieces constitutes less than half the total gross volume.

Residue distribution.—The distribution of residue over harvested areas is important in decisions concerning equipment needed to utilize these materials. Two factors that affect the type of equipment used to retrieve residue are slope and distance to the nearest road. The degree of slope of the harvested area determines whether ground-based or cable systems are required to yard the residue. Equipment limitations, such as maximum yarding distance, are determined by distance from the landing at roadside. As a rule, re-logging does not recover the cost of new road construction; thus, roads built during initial logging will generally be used for residue recovery operations.

Table 10 gives the average distribution of logging residue on cutover areas by slope and distance to the nearest road. This table includes residue in large piles, which are usually located adjacent to roads.

Application of Results



Ratios for estimating residue volume developed in this report have a variety of uses. A major use of these data will be for estimating the volume of residue expected from timber harvest activities within a uniquely defined supply zone. The following is a **hypothetical example** of how data in this report can be used to generate an estimate of the volume of residue for a specific location.

In this example, an estimate of annual residue volume is needed for a feasibility study of a proposed wood-fired power generation facility in Placerville, California. Figure 8 shows the proposed supply zone. The boundaries are based on existing transportation systems, timber harvest patterns, and an assumed cost-effective haul distance for residue of 75 miles. Although some residue outside the supply zone may be cheaper to recover than some within the zone, no attempt is made to account for it in this example. Both wood and bark residue is considered acceptable as fuel for the proposed facility.

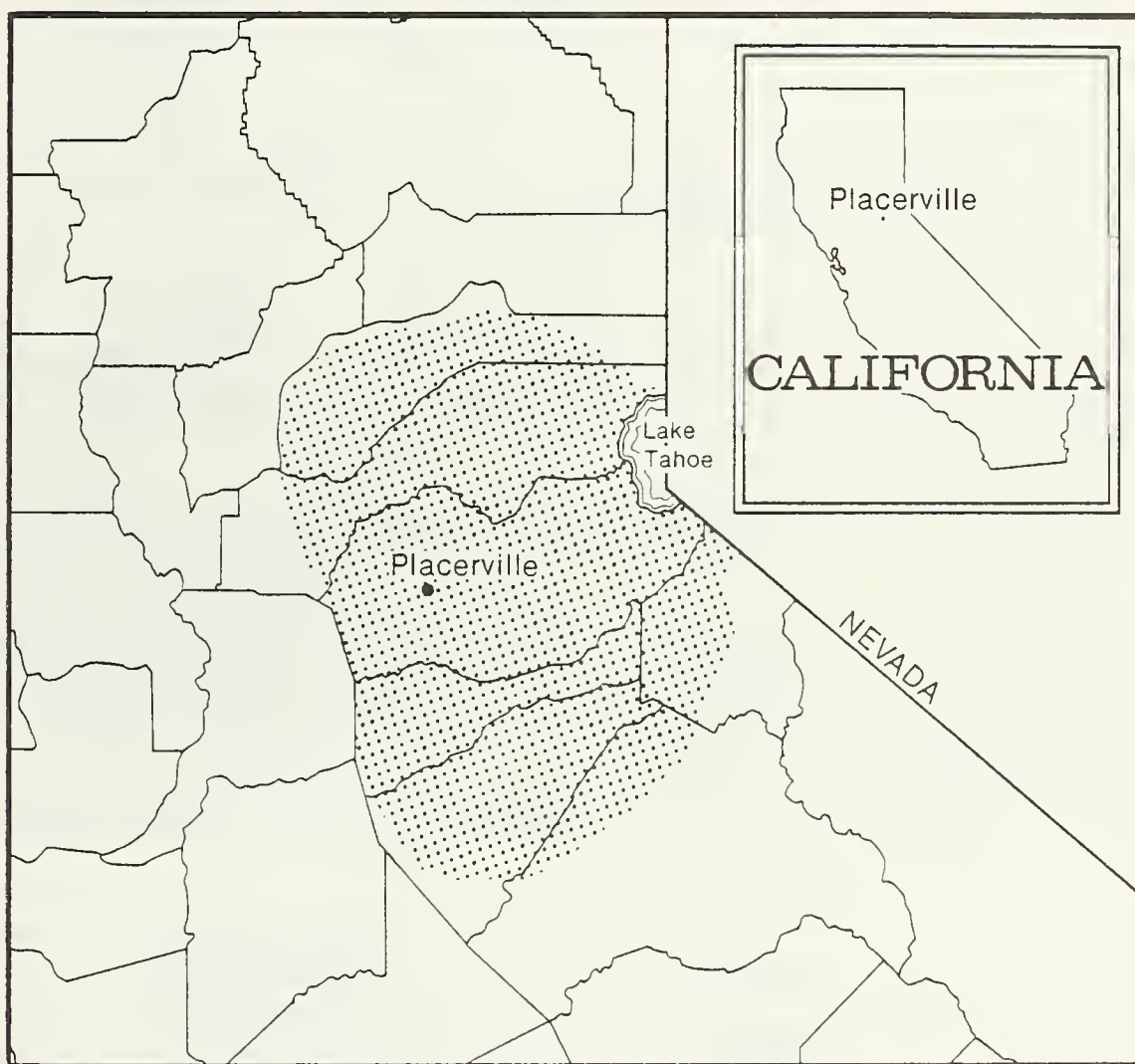


Figure 8.—Supply zone for a hypothetical wood-using facility located at Placerville, California.

Two types of data are needed to estimate residue volume for the supply zone: (1) annual harvest volume or acreage for each stratum within the supply zone, and (2) appropriate residue ratios corresponding to strata in the supply zone identified above. Harvest volumes must be determined from available timber harvest records. For this example, the ratio for net residue volume (wood and bark) is taken from table 1.

Shown below are the harvest volumes and residue ratios for the situation described.

<u>Stratum</u>	<u>Estimated annual harvest volume</u> (MBF)	<u>Residue ratio</u> (CF/MBF)
Interior:		
Public—		
Clearcut	119,248	47
Partial cut	189,659	79
Private	137,602	72
Ponderosa pine	48,886	83

Annual residue volume for the example can be estimated by multiplying the figures shown above as follows:

Public (clearcut)	$119,248 \times 47 = 5,604,656$ cubic feet
Public (partial cut)	$189,659 \times 79 = 14,983,061$ cubic feet
Private	$137,602 \times 72 = 9,907,344$ cubic feet
Ponderosa pine	$48,886 \times 83 = 4,057,538$ cubic feet
Total	34,552,599 cubic feet

The 35 million cubic feet of residue computed above represents an estimate of the total volume created annually. This amount might not be available for use because of other considerations. Equipment limitations, for example, might affect the minimum size piece that can be recovered. For the situation described above, it is assumed the planned equipment can only handle residue materials at least 8 inches in diameter and 8 feet in length. Information in table 7 can be used to estimate the proportion of the total volume of residue that meets this size requirement.

Information for modifying the total volume estimate is shown below:

<u>Stratum</u>	<u>Estimated total residue volume</u> (Cubic feet)	<u>Proportion of residue at least 8 inches in diameter and 8 feet in length</u>
Interior:		
Public—		
Clearcut	5,604,656	0.82
Partial cut	14,983,061	.81
Private	9,907,344	.84
Ponderosa pine	4,057,538	.85

The annual volume of residue meeting the minimum size criteria is determined by multiplying the above figures as follows:

Public (clearcut)	$5,604,656 \times 0.82 =$	4,595,818 cubic feet
Public (partial cut)	$14,983,061 \times 0.81 =$	12,136,279 cubic feet
Private	$9,907,344 \times 0.84 =$	8,322,169 cubic feet
Ponderosa pine	$4,057,538 \times 0.85 =$	<u>3,448,907 cubic feet</u>
Total		28,503,173 cubic feet

These computations show the estimated residue volume, meeting the minimum size requirement, to be approximately 28 million cubic feet. Again, the entire 28 million cubic feet of residue may not be available for use. For example, if the equipment used to recover the residue is limited to slopes of 35 percent or less, some of the above volume will be technically out of reach. The data in table 10 can be used to determine the impact of this limitation. Taking the volume of residue from the previous computation and appropriate figures from table 10 the following calculations can be made:

Public (clearcut)	$4,595,818 \times 0.694 =$	3,189,498 cubic feet
Public (partial cut)	$12,136,279 \times 0.760 =$	9,223,572 cubic feet
Private	$8,322,169 \times 0.766 =$	6,374,781 cubic feet
Ponderosa pine	$3,448,907 \times 0.832 =$	<u>2,869,491 cubic feet</u>
Total		21,657,342 cubic feet

Thus the limitation caused by equipment operability has further reduced the available residue volume to just less than 22 million cubic feet. This volume can be converted to weight by using density values shown in appendix 1. A composite value of 24 pounds (dry) per cubic foot is reasonable for the area included in this example. Using this figure the above 21.7 million cubic feet converts to about 260,000 bone dry tons. If no other factors are assumed to affect supply, this is the amount of residue available for use at the proposed facility.

Other factors, such as future harvest levels, competition for available supplies, management objectives, and cost considerations play an important part in determining the amount of residue available for energy conversion. It is the responsibility of the analyst to make these determinations. The above estimate, however, provides a good baseline for feasibility studies, such as that for the hypothetical situation described above.

Precision of Results



The data in this report represent a new level of information on logging residue in California and issues related to site-specific analyses. These data provide a basis not previously available for assessing logging residue, but they do have limitations. Table 11 gives the relevant statistical elements for determining precision of study results.

The indices of precision used here are based on gross wood volume of residue in cubic feet per acre (CF/AC), because the CF/AC volume of residue is the primary estimate provided by study measurements. Indices for CF/MBF ratios are not provided because they use actual timber harvest information provided by land owners. If errors in timber harvest volume exist, they are unknown.

Table 11—Statistical information for determination of sampling precision, by stratum

Stratum	Number of samples	Average gross volume (wood)	Standard error of the mean
<u>Cubic feet per acre</u>			
Coastal:			
Public--			
Clearcut	25	2,216	202.0
Partial cut	25	1,651	132.5
Private--			
Clearcut	27	2,483	219.2
Partial cut	30	2,227	245.3
Interior:			
Public--			
Clearcut	25	1,217	121.2
Partial cut	28	1,578	177.6
Private ^{1/}	35	1,527	169.3
Ponderosa pine ^{2/}	25	1,232	176.4

^{1/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{2/}Samples were selected from all harvest methods and ownership classes.

Table 12 gives the range of study data for selected characteristics. This information is included to provide additional insight into the application of study results. It may also be useful if application is intended for areas beyond the scope of this report, for example, if the supply zone for a selected site includes geographic areas outside the boundaries of this study. If data in this report are the only available source, the information in table 12 may help determine their usefulness, but application should be restricted to the range of data indicated in table 12. The level of accuracy associated with the results of this report does not apply to extensions beyond the scope of the study.

Table 12—Range of study data for stand age, harvest volume, area cut, and residue volume, by stratum

Stratum	Sample characteristics			
	Stand age	Harvest volume	Area cut	Net wood residue volume
	years	thousand fbm/acre	acres	ft ³ /acre
Coastal:				
Public--				
Clearcut	80-300	8- 73	5- 44	16-2,640
Partial cut	70-270	2- 45	7- 369	323-2,141
Private--				
Clearcut	60-650	3-135	7- 90	539-4,694
Partial cut	50-800	2-150	10- 637	261-3,360
Interior:				
Public--				
Clearcut	90-300	2- 62	6- 41	262-1,733
Partial cut	80-300	2- 44	6- 853	145-2,393
Private ^{1/}	70-270	3- 77	12-1,800	61-3,458
Ponderosa pine ^{2/}	100-350	3- 35	10- 840	56-3,462

^{1/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{2/}Samples were selected from all harvest methods and ownership classes.

Acknowledgments

The authors and the Biomass and Energy Project, Pacific Northwest Research Station acknowledge the U.S. Department of Energy for their financial support of this study. The recognized need for an extension of joint Forest Service/ Department of Energy studies for Idaho, Oregon, Washington, and Montana made this project possible. Special acknowledgment is made to the following:

- State of California, Department of Forestry, for financial support and for assistance in study planning and in communicating with the many land owners.
- USDA, Forest Service, Pacific Southwest Region, Aviation and Fire Management and Timber Management, for financial support, and particularly to Dick Harrell, for assistance in study planning and communication with Forest Service Ranger Districts.
- Ultrasystems, Incorporated, for financial support of this study.

In addition, many private companies and public agencies supported this study with expedient and thorough responses to our many inquiries. Their outstanding effort made this study successful.

Metric Equivalents

1 inch = 2.54 centimeters
1 foot = 30.48 centimeters
1 mile = 1.609 kilometers
1 acre = 0.405 hectare
1 cubic foot = 0.0283 cubic meter (stere)
1 pound = 0.454 kilogram
1 ton = 0.907 metric ton
1 British thermal unit (Btu) = 1,055.87 joules

Literature Cited

- Arola, Roger A.** Wood fuels—how do they stack up? In: Energy and the wood products industry: proceedings of a symposium; 1976 November 15-17; Atlanta, GA. Madison, WI: Forest Products Research Society; **1977**: p. 34-35.
- Bergvall, John A.; Bullington, Darryl C.; Gee, Loren; Koss, William.** Wood waste for energy study: inventory assessment and economic analysis. Olympia, WA: State of Washington, Department of Natural Resources; **1978**. 216 p.
- Howard, James O.** Logging residue in Washington, Oregon, and California: volume and characteristics. Resource Bull. PNW-44. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1973**. 26 p.
- Howard, James O.** A technique for predicting logging residue volumes in the Douglas-fir region. Res. Pap. PNW-225. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1978**. 26 p.
- Howard, James O.** Ratios for estimating logging residue in the Pacific Northwest. Res. Pap. PNW-288. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1981a**. 26 p.
- Howard, James O.** Logging residue in the Pacific Northwest: characteristics affecting utilization. Res. Pap. PNW-289. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1981b**. 41 p.
- Howard, James.; Fiedler, Carl E.** Estimators and characteristics of logging residue in Montana. Res. Pap. PNW-321. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1984**. 29 p.
- Howard, James O.; Ward, Franklin R.** Measurement of logging residue: alternative application of the line intersect method. Res. Note PNW-183. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1972**. 8 p.
- Little, Susan N.** Estimating the volume of wood in large piles. Admin. Rep. PNW-1. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1982**. 7 p.

Pickford, Stewart G.; Hazard, John W. Simulation studies on line intersect sampling of forest residue. *Forest Science*. 24(4):469-483; **1978**.

Snell, J.A. Kendall; Max, Timothy A. Bark-to-wood ratios for logging residue in Oregon, Washington, and Idaho. Admin. Rep. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1982**. 9 p.

U.S. Department of Agriculture, Forest Products Laboratory. Wood handbook: wood as an engineering material. Agric. Handb. 72 (rev.). Washington, DC: U.S. Department of Agriculture, Forest Service; **1974**.

Appendix 1

Wood Density and Heating Values for Selected Species

Species	Density, dry weight ^{1/} (Pounds per cubic foot)	Higher heating values, dry weight ^{2/} (BTU per pound)
Douglas-fir (<i>Pseudotsuga menziesii</i> (Mirb.) Franco)	28	9,050
Redwood (<i>Sequoia sempervirens</i> (D. Don.) Endl.)	24	8,770
Ponderosa pine (<i>Pinus ponderosa</i> Dougl. ex Laws.)	24	9,100
Lodgepole pine (<i>Pinus contorta</i> Dougl. ex Loud.)	24	8,730
Western white pine (<i>Pinus monticola</i> Dougl. ex D. Don)	22	— ^{3/}
Spruces (<i>Picea</i> spp.)	22	—
Western hemlock (<i>Tsuga heterophylla</i> (Raf.) Sarg.)	26	8,260
True firs (<i>Abies</i> spp.)	23	—
Western redcedar (<i>Thuja plicata</i> Donn. ex D. Don)	19	9,700
Western larch (<i>Larix occidentalis</i> Nutt.)	30	8,510
California black oak (<i>Quercus kelloggii</i> Newb.)	35	—
Oregon white oak (<i>Quercus garryana</i> Dougl. ex Hook.)	37	8,100
Aspen (<i>Populus tremuloides</i> Michx.)	22	—
Red alder (<i>Alnus rubra</i> Bong.)	23	8,000
Black cottonwood (<i>Populus trichocarpa</i> Torr. & Gray)	19	8,510

^{1/} USDA Forest Products Laboratory (1974).

^{2/} Arola (1977) and Bergvall and others (1978).

^{3/} = no information available.

Appendix 2
Tables 13-32

Table 13—Gross volume (wood only) of live logging residue, by small-end diameter and length classes, by stratum^{1/}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	17	25	17	54	49	23	186
	4.0-4.9	12	11	8	20	16	5	73
	5.0-5.9	1	2	2	4	5	0	17
	6.0-6.9	12	8	6	19	12	7	67
	7.0-7.9	1	1	2	2	1	0	9
	8.0-11.9	10	16	12	24	24	5	93
	12.0-15.9	8	4	9	44	7	5	79
	16.0-19.9	3	5	9	10	5	3	38
	20.0-27.9	9	6	30	12	27	0	86
	28.0+	23	12	0	0	33	0	69
Total		99	94	99	192	182	51	720
Partial cut	3.1-3.9	3	9	11	20	14	13	78
	4.0-4.9	3	6	3	14	4	1	38
	5.0-5.9	1	1	0	4	3	0	11
	6.0-6.9	7	5	6	9	1	2	31
	7.0-7.9	1	0	0	1	0	0	3
	8.0-11.9	4	1	3	11	5	1	33
	12.0-15.9	12	4	0	2	4	2	26
	16.0-19.9	6	9	6	10	2	0	34
	20.0-27.9	5	0	0	0	0	0	5
	28.0+	15	0	0	23	21	13	74
Total		72	38	36	97	59	35	340
Private--								
Clearcut	3.1-3.9	16	21	20	62	76	36	234
	4.0-4.9	13	9	10	36	45	19	134
	5.0-5.9	2	2	4	10	8	3	32
	6.0-6.9	10	5	8	37	33	16	111
	7.0-7.9	0	3	0	3	1	1	9
	8.0-11.9	7	21	11	52	45	10	149
	12.0-15.9	8	4	10	24	26	14	88
	16.0-19.9	6	13	6	27	21	2	78
	20.0-27.9	4	10	7	0	5	42	70
	28.0+	0	0	0	49	38	55	143
Total		69	92	79	305	304	204	1,055
Partial cut	3.1-3.9	7	8	9	38	37	15	117
	4.0-4.9	9	11	6	32	21	8	89
	5.0-5.9	1	2	1	8	3	0	17
	6.0-6.9	5	7	6	33	19	3	76
	7.0-7.9	0	0	0	0	1	0	3
	8.0-11.9	10	13	7	40	17	14	104
	12.0-15.9	12	8	3	28	22	2	78
	16.0-19.9	0	0	7	30	23	9	69
	20.0-27.9	5	4	0	16	0	0	26
	28.0+	0	0	9	20	17	27	75
Total		53	57	53	249	164	80	658

See footnotes at end of table.

Table 13—Gross volume (wood only) of live logging residue, by small-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	13	13	8	33	23	5	98
	4.0-4.9	10	7	7	24	8	1	59
	5.0-5.9	0	2	0	3	1	0	9
	6.0-6.9	6	8	5	10	8	3	43
	7.0-7.9	0	1	0	0	0	0	3
	8.0-11.9	11	5	5	16	14	6	59
	12.0-15.9	6	2	11	9	4	4	38
	16.0-19.9	3	5	3	4	2	0	19
	20.0-27.9	4	9	4	8	0	0	26
	28.0+	0	0	0	0	16	13	29
Total		56	56	47	110	80	34	386
Partial cut	3.1-3.9	12	10	9	21	12	5	73
	4.0-4.9	8	8	4	11	5	1	39
	5.0-5.9	2	2	0	3	0	0	10
	6.0-6.9	3	2	3	8	3	2	25
	7.0-7.9	0	1	0	0	0	0	1
	8.0-11.9	5	9	3	7	2	2	30
	12.0-15.9	13	0	9	8	1	0	32
	16.0-19.9	5	3	0	7	0	0	21
	20.0-27.9	9	0	8	0	12	0	30
	28.0+	11	11	0	8	12	18	63
Total		71	56	40	77	51	31	328
Private ^{2/}	3.1-3.9	14	13	10	23	22	10	94
	4.0-4.9	8	7	6	18	14	2	57
	5.0-5.9	0	3	2	4	7	1	19
	6.0-6.9	5	6	9	14	14	8	58
	7.0-7.9	1	1	2	7	3	0	17
	8.0-11.9	9	6	7	31	16	8	79
	12.0-15.9	6	7	6	10	5	0	37
	16.0-19.9	16	2	7	8	2	8	45
	20.0-27.9	14	4	13	4	15	0	52
	28.0+	0	0	0	0	0	0	0
Total		77	53	67	123	101	39	463
Ponderosa pine ^{3/}	3.1-3.9	11	3	5	13	15	3	57
	4.0-4.9	4	3	2	4	4	0	19
	5.0-5.9	0	1	0	1	1	0	5
	6.0-6.9	2	2	2	3	3	0	14
	7.0-7.9	1	1	0	0	0	0	4
	8.0-11.9	9	7	5	16	3	3	45
	12.0-15.9	3	4	6	5	6	0	25
	16.0-19.9	5	0	8	2	10	0	27
	20.0-27.9	14	18	0	17	0	0	50
	28.0+	0	0	0	0	0	0	0
Total		52	47	31	66	46	6	251

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 14—Gross volume (wood only) of logging residue, for softwoods, by small-end diameter and length classes, by stratum^{1/}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	38	39	25	61	34	8	208
	4.0-4.9	38	22	13	30	10	2	117
	5.0-5.9	5	3	3	7	2	0	22
	6.0-6.9	30	17	9	38	8	4	108
	7.0-7.9	3	2	3	2	2	0	13
	8.0-11.9	39	49	29	61	33	27	242
	12.0-15.9	28	16	26	90	25	23	210
	16.0-19.9	32	21	33	73	46	5	213
	20.0-27.9	28	36	69	67	64	48	316
	28.0+	27	24	0	45	103	13	214
Total		273	232	215	480	332	133	1,667
Partial cut	3.1-3.9	30	21	19	41	26	20	158
	4.0-4.9	33	20	12	31	13	3	113
	5.0-5.9	3	2	2	9	3	1	23
	6.0-6.9	22	15	10	23	17	4	93
	7.0-7.9	0	0	0	3	1	0	7
	8.0-11.9	27	20	30	58	63	10	211
	12.0-15.9	29	15	12	35	45	45	184
	16.0-19.9	20	27	20	32	36	59	197
	20.0-27.9	7	18	5	41	30	39	142
	28.0+	49	0	0	88	38	57	234
Total		224	141	115	365	276	243	1,366
Private--								
Clearcut	3.1-3.9	17	26	22	52	35	14	167
	4.0-4.9	19	16	13	28	24	8	110
	5.0-5.9	3	3	4	11	5	1	29
	6.0-6.9	17	13	12	48	16	5	113
	7.0-7.9	1	3	2	3	3	0	14
	8.0-11.9	21	37	42	72	54	12	241
	12.0-15.9	19	19	32	80	42	15	209
	16.0-19.9	9	30	26	81	54	9	211
	20.0-27.9	31	54	25	92	95	72	371
	28.0+	8	0	17	166	225	159	577
Total		149	205	199	638	557	297	2,048
Partial cut	3.1-3.9	12	11	10	36	26	6	104
	4.0-4.9	18	19	10	37	18	7	111
	5.0-5.9	2	2	3	7	2	1	19
	6.0-6.9	11	13	11	43	22	3	106
	7.0-7.9	0	1	1	2	1	0	6
	8.0-11.9	27	33	20	84	42	12	221
	12.0-15.9	16	21	19	59	43	9	170
	16.0-19.9	11	28	33	97	74	37	282
	20.0-27.9	18	24	4	90	98	45	282
	28.0+	0	0	107	208	191	136	643
Total		119	156	221	667	522	259	1,948

See footnotes at end of table.

Table 14—Gross volume (wood only) of logging residue, for softwoods, by small-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	24	18	9	39	30	6	129
	4.0-4.9	25	11	13	32	14	6	103
	5.0-5.9	1	3	1	5	3	0	16
	6.0-6.9	17	18	14	24	11	5	91
	7.0-7.9	0	1	1	4	0	0	8
	8.0-11.9	25	23	15	60	17	12	154
	12.0-15.9	14	8	32	54	20	17	147
	16.0-19.9	6	9	24	30	40	0	111
	20.0-27.9	11	9	8	26	53	7	118
	28.0+	0	0	0	21	101	69	192
Total		126	105	120	300	294	126	1,074
Partial cut	3.1-3.9	31	25	18	41	18	10	145
	4.0-4.9	29	18	10	25	14	5	102
	5.0-5.9	3	3	2	4	3	2	21
	6.0-6.9	17	14	11	25	11	7	87
	7.0-7.9	0	2	3	0	0	0	6
	8.0-11.9	23	24	15	44	35	21	164
	12.0-15.9	25	7	18	50	39	24	166
	16.0-19.9	14	25	14	47	28	16	146
	20.0-27.9	12	6	11	46	78	54	210
	28.0+	15	31	15	117	64	133	378
Total		175	160	121	404	292	276	1,430
Private ^{2/}	3.1-3.9	25	22	13	37	29	8	137
	4.0-4.9	24	17	13	28	26	3	114
	5.0-5.9	2	4	4	7	8	2	29
	6.0-6.9	21	17	15	29	25	9	119
	7.0-7.9	2	2	4	11	5	0	26
	8.0-11.9	28	22	28	67	32	17	197
	12.0-15.9	13	16	15	39	46	20	153
	16.0-19.9	25	10	12	59	36	28	173
	20.0-27.9	20	14	28	65	51	38	218
	28.0+	11	7	0	42	64	71	196
Total		176	136	136	388	327	200	1,365
Ponderosa pine ^{3/}	3.1-3.9	29	20	12	32	28	11	135
	4.0-4.9	20	10	5	19	6	3	65
	5.0-5.9	3	2	2	2	2	0	12
	6.0-6.9	10	8	6	16	10	14	68
	7.0-7.9	2	2	0	1	0	0	7
	8.0-11.9	28	40	11	56	36	32	206
	12.0-15.9	9	11	15	57	38	20	153
	16.0-19.9	12	7	20	66	43	45	196
	20.0-27.9	15	20	17	57	101	39	252
	28.0+	0	0	0	8	20	20	49
Total		132	125	93	320	288	187	1,148

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 15—Gross volume (wood only) of live logging residue, for softwoods, by small-end diameter and length classes, by stratum^{1/1}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	16	21	14	39	22	2	116
	4.0-4.9	11	10	8	15	7	1	55
	5.0-5.9	1	2	2	3	1	0	10
	6.0-6.9	11	7	4	15	4	3	47
	7.0-7.9	1	1	2	1	1	0	8
	8.0-11.9	8	15	11	17	12	2	67
	12.0-15.9	8	4	9	39	5	0	67
	16.0-19.9	3	5	9	10	5	0	34
	20.0-27.9	9	6	30	12	21	0	80
	28.0+	23	12	0	0	33	0	69
Total		94	87	93	154	117	10	558
Partial cut	3.1-3.9	7	8	9	16	10	11	63
	4.0-4.9	8	5	2	10	2	1	31
	5.0-5.9	1	0	0	4	2	0	9
	6.0-6.9	6	4	6	7	1	1	27
	7.0-7.9	0	0	0	1	0	0	2
	8.0-11.9	4	1	8	9	4	1	30
	12.0-15.9	11	1	0	2	4	2	21
	16.0-19.9	6	9	6	10	2	0	34
	20.0-27.9	5	0	0	0	0	0	5
	28.0+	15	0	0	23	21	13	74
Total		69	32	33	85	51	30	301
Private--								
Clearcut	3.1-3.9	10	14	15	37	32	12	123
	4.0-4.9	11	6	7	20	18	8	72
	5.0-5.9	2	2	4	9	4	1	24
	6.0-6.9	8	4	7	19	8	3	52
	7.0-7.9	0	2	0	2	1	0	6
	8.0-11.9	6	20	11	34	23	7	104
	12.0-15.9	8	4	10	20	12	12	69
	16.0-19.9	6	9	6	23	21	2	70
	20.0-27.9	4	10	7	0	5	42	70
	28.0+	0	0	0	49	38	55	143
Total		59	75	70	218	168	147	739
Partial cut	3.1-3.9	6	6	7	25	24	6	77
	4.0-4.9	8	10	3	24	13	3	63
	5.0-5.9	1	1	1	6	3	0	14
	6.0-6.9	5	7	4	26	16	2	62
	7.0-7.9	0	0	0	0	1	0	1
	8.0-11.9	10	12	4	31	12	7	79
	12.0-15.9	12	5	3	17	18	2	59
	16.0-19.9	0	0	7	23	20	9	59
	20.0-27.9	5	4	0	16	0	0	26
	28.0+	0	0	0	20	17	27	65
Total		50	48	33	194	126	57	510

See footnotes at end of table.

Table 15—Gross volume (wood only) of live logging residue, for softwoods, by small-end diameter and length classes, by stratum^{1/1} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	13	12	7	33	23	5	94
	4.0-4.9	9	7	7	23	8	1	57
	5.0-5.9	0	2	0	3	1	0	9
	6.0-6.9	6	8	5	10	8	1	40
	7.0-7.9	0	1	0	0	0	0	3
	8.0-11.9	11	5	5	16	4	5	47
	12.0-15.9	6	2	11	9	2	4	36
	16.0-19.9	3	5	0	4	0	0	13
	20.0-27.9	4	9	4	8	0	0	26
	28.0+	0	0	0	0	16	13	29
Total		55	55	42	109	65	30	358
Partial cut	3.1-3.9	12	10	9	20	10	5	69
	4.0-4.9	8	8	4	11	4	1	38
	5.0-5.9	2	2	0	3	0	0	10
	6.0-6.9	3	2	3	8	3	2	25
	7.0-7.9	0	1	0	0	0	0	1
	8.0-11.9	5	9	3	7	2	2	30
	12.0-15.9	13	0	9	8	1	0	32
	16.0-19.9	5	8	0	7	0	0	21
	20.0-27.9	9	0	8	0	12	0	30
	28.0+	11	11	0	8	12	18	63
Total		71	56	40	75	49	31	323
Private ^{2/}	3.1-3.9	13	13	9	22	17	6	82
	4.0-4.9	8	7	6	17	14	0	54
	5.0-5.9	0	2	2	4	7	1	19
	6.0-6.9	5	6	9	13	12	2	49
	7.0-7.9	1	1	2	7	3	0	17
	8.0-11.9	9	6	7	30	14	7	75
	12.0-15.9	6	7	6	10	5	0	37
	16.0-19.9	16	2	7	8	2	8	45
	20.0-27.9	14	4	13	4	15	0	52
	28.0+	0	0	0	0	0	0	0
Total		76	52	66	119	92	28	434
Ponderosa pine ^{3/}	3.1-3.9	11	8	5	13	15	3	57
	4.0-4.9	4	3	2	4	4	0	19
	5.0-5.9	0	1	0	1	1	0	5
	6.0-6.9	2	2	2	3	3	0	14
	7.0-7.9	1	1	0	0	0	0	4
	8.0-11.9	9	7	5	16	3	3	45
	12.0-15.9	3	4	6	5	6	0	25
	16.0-19.9	5	0	8	2	10	0	27
	20.0-27.9	14	18	0	17	0	0	50
	28.0+	0	0	0	0	0	0	0
Total		52	47	31	66	46	6	251

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 16—Net volume (wood only) of live logging residue, by small-end diameter and length classes, by stratum^{1/}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	17	24	17	55	50	23	189
	4.0-4.9	11	11	8	18	16	5	72
	5.0-5.9	1	2	2	4	5	1	17
	6.0-6.9	11	8	5	19	11	7	63
	7.0-7.9	1	1	2	2	1	0	8
	8.0-11.9	8	14	11	23	20	5	84
	12.0-15.9	5	3	9	41	7	5	73
	16.0-19.9	3	1	4	9	4	2	25
	20.0-27.9	3	6	26	9	18	0	69
	28.0+	24	7	0	0	12	0	44
Total		94	32	38	184	150	50	650
Partial cut	3.1-3.9	7	8	11	19	13	13	74
	4.0-4.9	7	5	3	13	4	1	35
	5.0-5.9	1	1	0	4	3	0	11
	6.0-6.9	4	4	5	8	0	2	26
	7.0-7.9	1	0	0	1	0	0	3
	8.0-11.9	4	1	7	9	4	0	27
	12.0-15.9	8	3	0	0	3	1	18
	16.0-19.9	6	7	5	7	2	0	28
	20.0-27.9	4	0	0	0	0	0	4
	28.0+	14	0	0	21	21	10	67
Total		61	32	33	86	54	30	299
Private--								
Clearcut	3.1-3.9	14	20	19	60	74	36	226
	4.0-4.9	10	3	9	34	44	19	127
	5.0-5.9	1	2	3	10	8	3	29
	6.0-6.9	8	4	7	34	31	16	103
	7.0-7.9	0	3	0	3	1	1	9
	8.0-11.9	6	17	9	48	43	10	135
	12.0-15.9	7	4	9	19	21	14	77
	16.0-19.9	4	9	4	25	20	2	66
	20.0-27.9	4	4	6	0	5	33	55
	28.0+	0	0	0	39	37	46	122
Total		58	75	70	276	289	134	954
Partial cut	3.1-3.9	7	3	9	36	35	14	112
	4.0-4.9	7	10	6	31	19	8	83
	5.0-5.9	1	2	1	8	3	0	17
	6.0-6.9	5	6	5	24	18	3	64
	7.0-7.9	0	0	0	0	1	0	3
	8.0-11.9	8	12	7	36	15	14	94
	12.0-15.9	12	8	3	26	20	2	73
	16.0-19.9	0	0	4	25	18	8	57
	20.0-27.9	3	4	0	13	0	0	20
	28.0+	0	0	9	18	6	26	62
Total		46	52	48	220	141	79	589

See footnotes at end of table.

Table 16—Net volume (wood only) of live logging residue, by small-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	13	13	7	33	23	5	97
	4.0-4.9	9	6	7	24	8	1	57
	5.0-5.9	0	2	0	2	1	0	9
	6.0-6.9	5	7	5	10	7	3	40
	7.0-7.9	0	1	0	0	0	0	3
	8.0-11.9	7	5	5	16	9	6	49
	12.0-15.9	5	2	10	9	4	4	35
	16.0-19.9	0	3	3	4	2	0	14
	20.0-27.9	5	4	4	7	0	0	21
	28.0+	0	0	0	0	13	10	24
Total		47	46	46	109	71	32	353
Partial cut	3.1-3.9	12	10	9	21	12	5	71
	4.0-4.9	7	7	4	11	5	1	37
	5.0-5.9	2	2	0	3	0	0	9
	6.0-6.9	3	2	3	8	3	2	24
	7.0-7.9	0	1	0	0	0	0	1
	8.0-11.9	4	8	3	7	2	2	28
	12.0-15.9	8	0	9	8	0	0	25
	16.0-19.9	4	5	0	5	0	0	15
	20.0-27.9	4	0	4	0	10	0	19
	28.0+	11	11	0	5	3	13	45
Total		59	50	34	71	38	25	280
Private ^{2/}	3.1-3.9	14	13	9	22	22	9	92
	4.0-4.9	7	6	6	16	14	2	53
	5.0-5.9	0	2	2	4	7	1	19
	6.0-6.9	4	6	9	14	14	8	57
	7.0-7.9	1	1	2	7	3	0	16
	8.0-11.9	8	4	6	28	16	8	72
	12.0-15.9	6	4	5	10	5	0	33
	16.0-19.9	8	2	6	6	2	8	34
	20.0-27.9	13	4	11	4	14	0	49
	28.0+	0	0	0	0	0	0	0
Total		65	47	61	116	99	38	429
Ponderosa pine ^{3/}	3.1-3.9	11	8	5	13	16	3	59
	4.0-4.9	4	3	2	4	4	0	19
	5.0-5.9	0	1	0	1	1	0	6
	6.0-6.9	2	2	2	3	3	0	14
	7.0-7.9	1	1	0	0	0	0	4
	8.0-11.9	7	8	5	15	3	3	43
	12.0-15.9	3	4	6	6	5	0	25
	16.0-19.9	3	0	7	2	11	0	25
	20.0-27.9	12	7	0	15	0	0	35
	28.0+	0	0	0	0	0	0	0
Total		47	37	31	63	47	6	233

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 17—Net volume (wood only) of logging residue, for softwoods, by small-end diameter and length classes, by stratum^{1/}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	- - - - -	- - - - -	Cubic feet per acre		- - - - -	- - - - -	
Coastal:								
Public--								
Clearcut	3.1-3.9	33	33	22	57	32	7	185
	4.0-4.9	26	19	12	25	10	1	96
	5.0-5.9	4	2	3	6	2	0	19
	6.0-6.9	21	13	8	29	7	4	84
	7.0-7.9	2	2	2	2	2	0	11
	8.0-11.9	22	28	20	42	23	18	157
	12.0-15.9	19	9	23	64	16	12	145
	16.0-19.9	14	6	17	42	31	4	116
	20.0-27.9	18	32	46	33	37	24	193
	28.0+	27	11	0	25	54	9	128
Total		191	159	156	328	219	83	1,139
Partial cut	3.1-3.9	21	17	15	32	19	15	122
	4.0-4.9	21	14	8	22	9	2	78
	5.0-5.9	2	1	2	7	3	1	18
	6.0-6.9	10	9	7	15	9	3	56
	7.0-7.9	0	0	0	3	1	0	6
	8.0-11.9	13	6	17	33	27	7	106
	12.0-15.9	14	4	2	15	17	36	91
	16.0-19.9	13	13	15	18	15	27	104
	20.0-27.9	5	2	1	12	8	17	48
	28.0+	17	0	0	41	27	34	122
Total		121	70	71	204	141	146	755
Private--								
Clearcut	3.1-3.9	12	21	19	46	33	13	147
	4.0-4.9	14	12	11	24	22	8	93
	5.0-5.9	1	2	3	10	5	1	25
	6.0-6.9	13	9	9	33	13	4	84
	7.0-7.9	0	3	1	2	2	0	11
	8.0-11.9	12	26	28	58	39	10	176
	12.0-15.9	11	12	22	48	27	14	137
	16.0-19.9	7	18	17	58	37	2	142
	20.0-27.9	19	32	14	52	43	50	212
	28.0+	4	0	15	87	127	113	348
Total		98	140	144	422	354	218	1,378
Partial cut	3.1-3.9	9	9	9	31	24	5	90
	4.0-4.9	11	14	7	30	15	6	86
	5.0-5.9	2	2	2	7	2	1	17
	6.0-6.9	8	9	8	26	19	2	75
	7.0-7.9	0	0	1	1	1	0	4
	8.0-11.9	16	20	13	47	27	10	136
	12.0-15.9	13	10	7	30	28	5	95
	16.0-19.9	5	11	18	48	45	29	158
	20.0-27.9	6	11	1	47	51	26	144
	28.0+	0	0	47	120	105	81	354
Total		73	91	116	393	322	168	1,165

See footnotes at end of table.

Table 17—Net volume (wood only) of logging residue, for softwoods, by small-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	21	18	10	40	30	6	127
	4.0-4.9	19	10	11	31	13	5	91
	5.0-5.9	1	3	1	4	2	0	14
	6.0-6.9	12	13	10	21	10	4	73
	7.0-7.9	0	1	1	3	0	0	6
	8.0-11.9	14	15	10	43	13	10	108
	12.0-15.9	9	5	19	29	9	14	88
	16.0-19.9	3	3	9	16	23	0	57
	20.0-27.9	9	4	9	15	28	3	70
	28.0+	0	0	0	11	48	39	99
Total		91	76	84	217	182	84	737
Partial cut	3.1-3.9	27	23	17	37	17	9	133
	4.0-4.9	23	15	9	21	11	3	84
	5.0-5.9	3	3	2	4	2	1	18
	6.0-6.9	11	10	8	18	9	5	64
	7.0-7.9	0	1	2	0	0	0	5
	8.0-11.9	14	16	10	31	19	16	110
	12.0-15.9	15	0	16	30	10	13	86
	16.0-19.9	7	13	5	24	13	0	64
	20.0-27.9	6	5	6	7	35	25	85
	28.0+	16	27	6	47	17	64	178
Total		126	118	84	224	138	139	832
Private ^{2/}	3.1-3.9	19	20	12	31	24	8	116
	4.0-4.9	16	12	10	23	21	2	86
	5.0-5.9	1	3	3	6	7	2	25
	6.0-6.9	11	11	12	22	18	8	85
	7.0-7.9	2	2	3	10	4	0	22
	8.0-11.9	16	11	14	44	25	12	126
	12.0-15.9	11	10	10	23	27	9	92
	16.0-19.9	10	4	8	26	20	18	88
	20.0-27.9	19	5	17	30	23	20	116
	28.0+	6	4	0	19	23	44	98
Total		117	87	95	237	196	126	860
Ponderosa pine ^{3/}	3.1-3.9	23	19	11	25	28	7	116
	4.0-4.9	13	8	4	13	6	2	48
	5.0-5.9	2	2	2	2	1	0	11
	6.0-6.9	4	5	5	10	7	12	48
	7.0-7.9	1	2	0	1	0	0	7
	8.0-11.9	16	24	10	36	22	21	132
	12.0-15.9	6	5	10	23	22	8	78
	16.0-19.9	5	2	12	18	26	20	86
	20.0-27.9	13	8	9	29	30	20	112
	28.0+	0	0	0	2	4	7	14
Total		88	79	68	166	152	102	656

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 18—Net volume (wood only) of live logging residue, for softwoods, by small-end diameter and length classes, by stratum^{1/1}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	16	20	14	40	23	2	118
	4.0-4.9	11	10	8	15	8	1	54
	5.0-5.9	1	1	2	3	1	0	10
	6.0-6.9	10	7	4	15	4	3	46
	7.0-7.9	1	1	2	1	1	0	8
	8.0-11.9	6	13	10	16	8	2	58
	12.0-15.9	5	3	9	35	6	0	60
	16.0-19.9	3	1	4	9	4	0	23
	20.0-27.9	8	6	26	9	13	0	65
	28.0+	24	7	0	0	12	0	44
Total		88	75	83	147	85	10	490
Partial cut	3.1-3.9	7	8	9	15	9	11	60
	4.0-4.9	7	5	2	9	2	1	29
	5.0-5.9	1	0	0	4	2	0	9
	6.0-6.9	4	3	5	6	0	1	21
	7.0-7.9	0	0	0	1	0	0	2
	8.0-11.9	4	1	7	8	3	0	25
	12.0-15.9	7	1	0	0	3	1	14
	16.0-19.9	6	7	5	7	2	0	28
	20.0-27.9	4	0	0	0	0	0	4
	28.0+	14	0	0	21	21	10	67
Total		58	27	30	74	46	25	263
Private--								
Clearcut	3.1-3.9	8	13	14	35	31	12	117
	4.0-4.9	9	5	7	19	17	8	66
	5.0-5.9	1	1	3	9	4	1	22
	6.0-6.9	7	4	6	18	7	3	47
	7.0-7.9	0	2	0	2	1	0	5
	8.0-11.9	5	16	9	31	21	7	92
	12.0-15.9	7	4	9	16	9	12	60
	16.0-19.9	4	6	4	20	20	2	59
	20.0-27.9	4	4	6	0	5	33	55
	28.0+	0	0	0	39	37	46	122
Total		49	59	61	193	157	128	649
Partial cut	3.1-3.9	6	6	7	24	23	6	75
	4.0-4.9	6	9	3	24	11	3	58
	5.0-5.9	1	1	1	6	3	0	14
	6.0-6.9	5	6	4	17	15	2	50
	7.0-7.9	0	0	0	0	1	0	1
	8.0-11.9	8	10	3	28	10	7	69
	12.0-15.9	12	4	3	15	16	2	54
	16.0-19.9	0	0	4	18	18	8	50
	20.0-27.9	3	4	0	13	0	0	20
	28.0+	0	0	0	18	6	26	52
Total		43	43	29	168	108	56	448

See footnotes at end of table.

Table 18—Net volume (wood only) of live logging residue, for softwoods, by small-end diameter and length classes, by stratum^{1/1} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
Interior:	Inches	Cubic feet per acre						
Public--								
Clearcut	3.1-3.9	13	12	7	33	23	5	94
	4.0-4.9	8	6	7	23	8	1	55
	5.0-5.9	0	2	0	2	1	0	8
	6.0-6.9	5	7	5	10	7	1	38
	7.0-7.9	0	1	0	0	0	0	3
	8.0-11.9	7	5	5	16	4	5	44
	12.0-15.9	5	2	10	9	2	4	33
	16.0-19.9	0	3	0	4	0	0	8
	20.0-27.9	5	4	4	7	0	0	21
	28.0+	0	0	0	0	13	10	24
Total		46	45	41	107	61	28	331
Partial cut	3.1-3.9	11	10	9	19	10	5	68
	4.0-4.9	7	7	4	11	4	1	37
	5.0-5.9	2	2	0	3	0	0	9
	6.0-6.9	3	2	3	8	3	2	24
	7.0-7.9	0	1	0	0	0	0	1
	8.0-11.9	4	8	3	7	2	2	28
	12.0-15.9	8	0	9	8	0	0	25
	16.0-19.9	4	5	0	5	0	0	15
	20.0-27.9	4	0	4	0	10	0	19
	28.0+	11	11	0	5	3	13	45
Total		58	50	34	70	36	25	275
Private ^{2/}	3.1-3.9	12	13	9	21	17	6	80
	4.0-4.9	7	6	6	15	13	0	51
	5.0-5.9	0	2	2	4	7	1	18
	6.0-6.9	4	6	9	13	12	2	47
	7.0-7.9	1	1	2	7	3	0	16
	8.0-11.9	8	4	6	27	13	7	68
	12.0-15.9	6	4	5	10	5	0	33
	16.0-19.9	8	2	6	6	2	8	34
	20.0-27.9	13	4	11	4	14	0	49
	28.0+	0	0	0	0	0	0	0
Total		64	46	60	111	90	27	401
Ponderosa pine ^{3/}	3.1-3.9	11	8	5	13	16	3	59
	4.0-4.9	4	3	2	4	4	0	19
	5.0-5.9	0	1	0	1	1	0	6
	6.0-6.9	2	2	2	3	3	0	14
	7.0-7.9	1	1	0	0	0	0	4
	8.0-11.9	7	8	5	15	3	3	43
	12.0-15.9	3	4	6	6	5	0	25
	16.0-19.9	3	0	7	2	11	0	25
	20.0-27.9	12	7	0	15	0	0	35
	28.0+	0	0	0	0	0	0	0
Total		47	37	31	63	47	6	233

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 19—Net volume (wood only) of logging residue, by large-end diameter and length classes, by stratum^{1/}

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
		Inches	Cubic feet per acre					
Coastal: Public-- Clearcut	3.1-3.9	14	6	4	1	0	0	27
	4.0-4.9	34	30	19	30	5	0	120
	5.0-5.9	6	6	4	16	5	1	39
	6.0-6.9	26	18	13	33	21	0	113
	7.0-7.9	0	3	1	7	4	0	18
	8.0-11.9	29	24	20	70	64	19	229
	12.0-15.9	22	11	25	61	31	19	173
	16.0-19.9	17	23	13	65	42	20	183
	20.0-27.9	16	35	38	55	48	24	218
	28.0+	33	11	22	36	80	42	226
Total		203	172	163	378	303	129	1,351
Partial cut	3.1-3.9	8	2	2	2	0	0	15
	4.0-4.9	25	20	14	18	5	0	84
	5.0-5.9	2	2	1	9	4	0	20
	6.0-6.9	14	13	13	29	13	1	86
	7.0-7.9	0	2	1	6	2	0	13
	8.0-11.9	18	13	16	57	32	9	143
	12.0-15.9	19	3	9	36	28	12	110
	16.0-19.9	16	16	14	15	26	13	102
	20.0-27.9	5	6	7	23	14	31	88
	28.0+	17	0	0	45	37	81	181
Total		128	80	81	244	165	151	851
Private-- Clearcut	3.1-3.9	6	3	3	2	0	0	16
	4.0-4.9	21	23	15	31	10	0	102
	5.0-5.9	2	4	5	17	8	0	39
	6.0-6.9	14	14	13	53	28	3	126
	7.0-7.9	0	3	2	10	7	0	26
	8.0-11.9	16	37	35	96	110	35	331
	12.0-15.9	14	9	19	68	71	35	218
	16.0-19.9	9	21	26	45	46	18	167
	20.0-27.9	14	45	22	95	80	36	294
	28.0+	9	0	16	112	134	144	417
Total		109	161	160	533	498	277	1,741
Partial cut	3.1-3.9	3	1	1	0	0	0	7
	4.0-4.9	14	15	13	26	7	0	76
	5.0-5.9	1	3	2	7	3	0	17
	6.0-6.9	10	13	7	27	18	2	79
	7.0-7.9	0	2	1	4	4	1	15
	8.0-11.9	22	24	22	71	50	17	209
	12.0-15.9	13	18	13	51	40	18	155
	16.0-19.9	6	8	10	58	26	11	121
	20.0-27.9	6	15	12	71	73	26	206
	28.0+	0	4	56	145	165	112	485
Total		78	107	140	466	390	190	1,373

See footnotes at end of table.

Table 19—Net volume (wood only) of logging residue, by large-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	6	1	0	0	0	0	10
	4.0-4.9	25	16	11	17	3	0	73
	5.0-5.9	2	4	1	6	0	0	15
	6.0-6.9	17	14	10	37	11	0	91
	7.0-7.9	0	1	0	4	3	0	11
	8.0-11.9	18	20	16	46	35	8	145
	12.0-15.9	8	8	21	35	23	4	101
	16.0-19.9	6	7	9	16	16	13	69
	20.0-27.9	9	4	18	45	43	13	134
	28.0+	0	0	0	13	56	47	118
Total		94	78	90	223	193	89	770
Partial cut	3.1-3.9	14	4	1	0	0	0	21
	4.0-4.9	28	22	15	19	3	0	89
	5.0-5.9	2	2	2	7	2	0	18
	6.0-6.9	17	11	7	25	8	0	70
	7.0-7.9	0	3	3	4	2	0	15
	8.0-11.9	16	24	17	49	20	5	134
	12.0-15.9	14	5	9	28	19	8	85
	16.0-19.9	11	13	16	23	18	3	86
	20.0-27.9	0	5	6	17	27	21	77
	28.0+	22	27	6	50	40	101	249
Total		127	120	86	228	143	142	849
Private ^{2/}	3.1-3.9	10	4	0	0	0	0	16
	4.0-4.9	19	19	9	18	2	0	70
	5.0-5.9	1	3	3	8	2	0	19
	6.0-6.9	14	17	15	23	16	0	88
	7.0-7.9	0	1	2	7	4	0	18
	8.0-11.9	21	16	23	64	53	13	192
	12.0-15.9	12	8	8	33	35	13	111
	16.0-19.9	12	6	13	29	23	7	92
	20.0-27.9	19	7	19	32	33	34	148
	28.0+	6	5	0	25	41	68	148
Total		120	90	98	244	213	138	906
Ponderosa pine ^{3/}	3.1-3.9	10	1	0	0	0	0	13
	4.0-4.9	19	13	6	8	1	0	49
	5.0-5.9	3	1	2	4	1	0	13
	6.0-6.9	9	7	6	15	8	0	47
	7.0-7.9	0	1	1	3	2	1	10
	8.0-11.9	17	21	11	42	28	2	125
	12.0-15.9	9	14	15	28	21	7	96
	16.0-19.9	5	6	12	20	22	19	86
	20.0-27.9	13	7	9	28	33	37	130
	28.0+	0	1	0	15	32	33	83
Total		88	79	68	166	152	102	657

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 20—Gross volume (wood only) of logging residue, by large-end diameter and length classes, by stratum^{1/}

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	17	7	4	1	0	0	31
	4.0-4.9	42	32	21	32	5	0	135
	5.0-5.9	7	7	4	17	5	1	44
	6.0-6.9	34	22	15	37	21	0	133
	7.0-7.9	0	4	2	7	4	0	20
	8.0-11.9	50	35	26	84	66	20	285
	12.0-15.9	31	18	28	97	35	20	232
	16.0-19.9	38	45	22	107	54	25	293
	20.0-27.9	31	48	73	102	72	35	363
	28.0+	34	24	24	56	154	78	373
Total		288	247	223	545	422	183	1,910
Partial cut	3.1-3.9	11	3	2	2	0	0	19
	4.0-4.9	35	25	18	22	6	0	110
	5.0-5.9	3	3	2	10	6	0	26
	6.0-6.9	23	20	17	38	17	2	120
	7.0-7.9	0	2	1	7	2	0	16
	8.0-11.9	38	26	24	86	47	14	237
	12.0-15.9	36	13	22	60	54	17	205
	16.0-19.9	28	37	18	34	57	16	193
	20.0-27.9	7	22	18	55	54	49	207
	28.0+	49	0	0	97	63	149	360
Total		235	154	128	416	311	251	1,497
Private--								
Clearcut	3.1-3.9	7	3	3	2	0	0	18
	4.0-4.9	26	26	16	33	10	0	113
	5.0-5.9	3	4	5	18	9	0	41
	6.0-6.9	19	17	14	61	28	4	145
	7.0-7.9	1	4	3	11	8	0	29
	8.0-11.9	28	50	48	111	119	36	393
	12.0-15.9	24	14	27	88	85	38	279
	16.0-19.9	14	34	41	68	61	20	242
	20.0-27.9	24	74	38	158	131	48	476
	28.0+	16	0	17	202	249	208	693
Total		165	230	218	755	706	359	2,435
Partial cut	3.1-3.9	4	1	1	0	0	0	8
	4.0-4.9	19	19	14	28	7	0	89
	5.0-5.9	1	3	3	8	3	0	21
	6.0-6.9	15	17	9	34	20	2	100
	7.0-7.9	0	2	1	4	4	1	16
	8.0-11.9	35	36	30	93	57	18	271
	12.0-15.9	18	25	21	85	50	19	221
	16.0-19.9	12	26	21	94	52	17	225
	20.0-27.9	18	27	25	150	127	33	384
	28.0+	0	15	116	255	277	188	853
Total		126	177	247	756	602	281	2,192

See footnotes at end of table.

Table 20—Gross volume (wood only) of logging residue, by large-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Interior: Public-- Clearcut	3.1-3.9	7	2	1	0	0	0	11
	4.0-4.9	30	16	11	17	3	0	80
	5.0-5.9	2	4	1	6	0	0	15
	6.0-6.9	21	16	11	38	12	0	101
	7.0-7.9	0	1	0	4	2	0	10
	8.0-11.9	30	28	21	54	37	10	181
	12.0-15.9	16	12	28	57	32	4	153
	16.0-19.9	9	16	18	36	26	17	123
	20.0-27.9	11	9	30	63	74	16	206
	28.0+	0	0	0	29	121	80	231
Total		130	108	125	309	312	130	1,117
Partial cut	3.1-3.9	16	5	1	0	0	0	24
	4.0-4.9	34	24	16	20	3	0	99
	5.0-5.9	2	2	2	8	2	0	19
	6.0-6.9	21	13	8	28	8	0	82
	7.0-7.9	0	4	3	5	2	0	16
	8.0-11.9	27	33	25	59	25	6	177
	12.0-15.9	23	11	12	47	32	10	138
	16.0-19.9	21	28	25	35	47	5	164
	20.0-27.9	0	6	11	73	64	70	227
	28.0+	28	31	15	128	112	184	501
Total		177	163	124	408	299	279	1,452
Private ^{2/}	3.1-3.9	13	4	1	0	0	0	20
	4.0-4.9	26	23	11	21	2	0	86
	5.0-5.9	1	3	4	10	2	0	21
	6.0-6.9	24	21	18	29	19	0	113
	7.0-7.9	1	2	2	8	5	0	21
	8.0-11.9	34	27	32	81	67	15	258
	12.0-15.9	17	16	19	56	45	15	171
	16.0-19.9	28	11	20	57	42	8	168
	20.0-27.9	20	20	30	74	67	53	267
	28.0+	11	7	0	57	96	118	292
Total		180	139	140	397	350	213	1,422
Ponderosa pine ^{3/}	3.1-3.9	11	2	0	0	0	0	14
	4.0-4.9	26	15	8	9	1	0	60
	5.0-5.9	3	1	2	5	1	0	14
	6.0-6.9	16	10	7	17	9	0	62
	7.0-7.9	0	2	1	3	2	1	11
	8.0-11.9	31	31	14	61	30	2	172
	12.0-15.9	14	21	20	52	29	7	146
	16.0-19.9	12	15	15	61	34	27	167
	20.0-27.9	15	16	21	63	77	66	261
	28.0+	0	8	0	47	101	82	239
Total		132	126	93	320	288	187	1,149

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 21—Gross volume (wood only) of live logging residue, by large-end diameter and length classes, by stratum^{1/}

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	<u>Inches</u>	- - - - -	- - - - -	<u>Cubic feet per acre</u>		- - - - -	- - - - -	
Coastal:								
Public--								
Clearcut	3.1-3.9	6	4	2	0	0	0	14
	4.0-4.9	16	18	13	21	4	0	75
	5.0-5.9	3	3	2	11	3	0	26
	6.0-6.9	11	10	8	23	15	0	69
	7.0-7.9	0	1	1	5	3	0	11
	8.0-11.9	14	13	13	40	49	14	145
	12.0-15.9	9	7	9	34	17	15	93
	16.0-19.9	5	16	3	25	22	9	84
	20.0-27.9	9	6	21	20	18	0	77
	28.0+	23	12	20	8	48	9	123
Total		99	94	99	192	182	51	720
Partial cut	3.1-3.9	3	1	0	1	0	0	7
	4.0-4.9	9	8	8	7	2	0	37
	5.0-5.9	0	1	1	6	1	0	10
	6.0-6.9	5	6	6	13	7	1	40
	7.0-7.9	0	0	0	2	1	0	4
	8.0-11.9	9	4	9	24	12	4	65
	12.0-15.9	12	2	4	8	7	8	43
	16.0-19.9	9	9	6	0	5	6	36
	20.0-27.9	5	3	0	10	0	0	19
	28.0+	15	0	0	23	21	13	74
Total		72	38	36	97	59	35	340
Private--								
Clearcut	3.1-3.9	3	2	3	2	0	0	12
	4.0-4.9	16	18	11	25	9	0	82
	5.0-5.9	1	3	3	15	8	0	32
	6.0-6.9	9	9	11	47	26	3	109
	7.0-7.9	0	3	1	9	7	0	22
	8.0-11.9	14	22	20	72	99	35	264
	12.0-15.9	11	3	10	33	45	33	137
	16.0-19.9	6	15	8	23	37	17	110
	20.0-27.9	4	14	7	24	31	25	107
	28.0+	0	0	0	49	38	86	175
Total		69	92	79	305	304	204	1,055
Partial cut	3.1-3.9	2	0	1	0	0	0	4
	4.0-4.9	9	11	11	23	6	0	62
	5.0-5.9	0	1	0	6	2	0	12
	6.0-6.9	7	10	4	22	16	2	63
	7.0-7.9	0	1	1	3	4	1	12
	8.0-11.9	14	15	11	56	45	17	160
	12.0-15.9	12	11	6	35	26	14	108
	16.0-19.9	1	0	0	45	12	5	64
	20.0-27.9	5	4	7	25	18	9	69
	28.0+	0	0	9	29	31	29	100
Total		53	57	53	249	164	80	658

See footnotes at end of table.

Table 21—Gross volume (wood only) of live logging residue, by large-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	- - - - -	- - - - -	Cubic feet per acre		- - - - -	- - - - -	
Interior: Public--								
Clearcut	3.1-3.9	3	0	0	0	0	0	6
	4.0-4.9	14	10	8	11	2	0	47
	5.0-5.9	1	2	0	5	0	0	11
	6.0-6.9	8	8	7	25	8	0	58
	7.0-7.9	0	1	0	3	2	0	7
	8.0-11.9	11	12	7	32	26	5	96
	12.0-15.9	6	1	13	8	10	1	41
	16.0-19.9	5	8	2	4	4	5	30
	20.0-27.9	4	9	7	17	9	8	56
	28.0+	0	0	0	0	16	13	29
Total		56	56	47	110	80	34	386
Partial cut	3.1-3.9	6	1	0	0	0	0	8
	4.0-4.9	12	11	8	10	1	0	44
	5.0-5.9	1	1	1	4	1	0	10
	6.0-6.9	5	5	2	13	5	0	32
	7.0-7.9	0	2	1	2	2	0	8
	8.0-11.9	4	10	6	20	7	2	51
	12.0-15.9	9	3	5	7	6	4	36
	16.0-19.9	10	8	5	7	1	0	34
	20.0-27.9	0	0	8	2	4	4	19
	28.0+	20	11	0	8	21	18	80
Total		71	56	40	77	51	31	328
Private ^{2/}	3.1-3.9	6	3	0	0	0	0	11
	4.0-4.9	12	12	7	14	1	0	47
	5.0-5.9	0	2	2	6	1	0	13
	6.0-6.9	6	11	10	16	10	0	55
	7.0-7.9	0	1	2	5	3	0	13
	8.0-11.9	13	8	12	45	42	9	131
	12.0-15.9	6	7	6	16	21	10	69
	16.0-19.9	16	0	8	12	1	6	45
	20.0-27.9	14	7	15	6	12	10	65
	28.0+	0	0	0	0	6	0	7
Total		77	53	67	123	101	39	463
Ponderosa pine ^{3/}	3.1-3.9	4	1	0	0	0	0	6
	4.0-4.9	8	7	3	3	0	0	23
	5.0-5.9	1	1	1	2	0	0	6
	6.0-6.9	2	2	2	6	5	0	20
	7.0-7.9	0	0	0	2	1	0	5
	8.0-11.9	11	8	5	19	18	0	63
	12.0-15.9	3	6	9	8	4	1	34
	16.0-19.9	5	0	8	4	8	3	31
	20.0-27.9	14	11	0	12	3	0	41
	28.0+	0	7	0	5	3	0	17
Total		52	47	31	66	46	6	251

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 22—Gross volume (wood only) of logging residue, for softwoods, by large-end diameter and length classes, by stratum^{1/}

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	- - - - -	- - - - -	Cubic feet per acre		- - - - -	- - - - -	
Coastal: Public-- Clearcut	3.1-3.9	15	6	3	1	0	0	27
	4.0-4.9	40	29	18	26	4	0	119
	5.0-5.9	7	5	4	13	4	0	36
	6.0-6.9	32	20	14	29	14	0	111
	7.0-7.9	0	2	2	7	3	0	17
	8.0-11.9	47	32	22	65	36	8	213
	12.0-15.9	29	16	28	18	13	3	174
	16.0-19.9	38	45	22	102	40	17	267
	20.0-27.9	26	48	73	94	60	35	337
	28.0+	34	24	24	56	154	67	361
Total		273	232	215	480	332	133	1,667
Partial cut	3.1-3.9	10	2	2	2	0	0	17
	4.0-4.9	33	23	16	19	6	0	99
	5.0-5.9	3	2	2	8	5	0	22
	6.0-6.9	22	19	16	30	16	2	108
	7.0-7.9	0	2	1	6	2	0	13
	8.0-11.9	35	20	21	68	39	11	197
	12.0-15.9	32	13	21	50	45	13	177
	16.0-19.9	28	37	15	26	48	16	173
	20.0-27.9	7	18	18	53	48	49	195
	28.0+	49	0	0	97	63	149	360
Total		224	141	115	365	276	243	1,366
Private-- Clearcut	3.1-3.9	7	3	2	1	0	0	15
	4.0-4.9	18	19	11	20	5	0	76
	5.0-5.9	3	2	4	12	4	0	28
	6.0-6.9	17	13	12	39	12	2	98
	7.0-7.9	1	3	2	6	5	0	19
	8.0-11.9	23	44	44	70	57	14	255
	12.0-15.9	23	14	26	76	54	12	207
	16.0-19.9	14	34	41	66	39	14	212
	20.0-27.9	24	70	34	154	127	44	455
	28.0+	16	0	17	188	249	208	679
Total		149	205	199	638	557	297	2,048
Partial cut	3.1-3.9	3	1	0	0	0	0	7
	4.0-4.9	16	16	11	22	5	0	73
	5.0-5.9	1	3	2	7	2	0	17
	6.0-6.9	13	14	6	25	14	1	75
	7.0-7.9	0	2	1	4	3	0	12
	8.0-11.9	34	33	23	74	40	8	213
	12.0-15.9	18	20	19	74	39	12	185
	16.0-19.9	12	24	21	78	38	13	189
	20.0-27.9	18	25	25	136	125	33	366
	28.0+	0	15	107	243	253	188	808
Total		119	156	221	667	522	259	1,948

See footnotes at end of table.

Table 22—Gross volume (wood only) of logging residue, for softwoods, by large-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	6	2	1	0	0	0	10
	4.0-4.9	28	15	10	16	3	0	73
	5.0-5.9	2	4	1	6	0	0	15
	6.0-6.9	20	15	11	36	12	0	97
	7.0-7.9	0	1	0	4	2	0	10
	8.0-11.9	29	28	21	50	37	10	177
	12.0-15.9	16	12	28	55	29	3	146
	16.0-19.9	9	16	18	36	22	14	117
	20.0-27.9	11	9	27	63	63	16	192
	28.0+	0	0	0	29	121	80	231
Total		126	105	120	300	294	126	1,074
Partial cut	3.1-3.9	16	5	1	0	0	0	23
	4.0-4.9	34	24	16	20	3	0	98
	5.0-5.9	2	2	2	7	2	0	18
	6.0-6.9	21	13	8	27	7	0	80
	7.0-7.9	0	4	3	5	2	0	15
	8.0-11.9	27	31	23	57	21	6	168
	12.0-15.9	22	11	12	47	30	10	135
	16.0-19.9	21	28	25	35	47	2	160
	20.0-27.9	0	6	11	73	64	70	227
	28.0+	28	31	15	128	112	184	501
Total		175	160	121	404	292	276	1,430
Private ^{2/}	3.1-3.9	13	4	1	0	0	0	19
	4.0-4.9	25	22	10	20	2	0	81
	5.0-5.9	1	3	3	10	2	0	21
	6.0-6.9	24	20	17	27	18	0	107
	7.0-7.9	1	2	2	8	5	0	21
	8.0-11.9	33	27	31	77	63	9	243
	12.0-15.9	15	15	18	54	38	10	153
	16.0-19.9	28	11	20	57	40	6	165
	20.0-27.9	20	20	30	74	60	52	259
	28.0+	11	7	0	57	96	118	292
Total		176	136	136	388	327	200	1,365
Ponderosa pine ^{3/}	3.1-3.9	11	2	0	0	0	0	14
	4.0-4.9	26	15	8	9	1	0	60
	5.0-5.9	3	1	2	5	1	0	13
	6.0-6.9	16	10	7	17	9	0	61
	7.0-7.9	0	2	1	3	2	1	11
	8.0-11.9	31	31	14	61	30	2	172
	12.0-15.9	14	21	20	52	29	7	146
	16.0-19.9	12	15	15	61	34	27	167
	20.0-27.9	15	16	21	63	77	66	261
	28.0+	0	8	0	47	101	82	239
Total		132	125	93	320	288	187	1,148

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 23—Gross volume (wood only) of live logging residue, for softwoods, by large-end diameter and length classes, by stratum^{1/}

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	5	3	2	0	0	0	11
	4.0-4.9	15	16	11	17	2	0	65
	5.0-5.9	3	3	2	8	3	0	21
	6.0-6.9	10	8	7	16	9	0	53
	7.0-7.9	0	1	1	5	2	0	10
	8.0-11.9	13	12	11	27	24	4	93
	12.0-15.9	7	7	9	25	1	2	54
	16.0-19.9	5	16	3	21	11	3	62
	20.0-27.9	9	6	21	20	12	0	71
	28.0+	23	12	20	8	48	0	113
Total		94	87	93	154	117	10	558
Partial cut	3.1-3.9	3	1	0	1	0	0	7
	4.0-4.9	8	7	7	6	1	0	32
	5.0-5.9	0	0	0	5	1	0	9
	6.0-6.9	5	6	5	10	7	0	36
	7.0-7.9	0	0	0	1	0	0	3
	8.0-11.9	9	3	7	19	9	2	51
	12.0-15.9	11	2	4	6	3	6	34
	16.0-19.9	9	9	6	0	5	6	36
	20.0-27.9	5	0	0	10	0	0	16
	28.0+	15	0	0	23	21	13	74
Total		69	32	33	85	51	30	301
Private--								
Clearcut	3.1-3.9	3	2	1	1	0	0	9
	4.0-4.9	11	12	8	15	4	0	52
	5.0-5.9	1	1	2	10	3	0	21
	6.0-6.9	7	7	10	28	10	2	66
	7.0-7.9	0	2	1	6	4	0	15
	8.0-11.9	11	19	18	41	41	13	146
	12.0-15.9	11	3	10	23	18	7	75
	16.0-19.9	6	15	8	21	15	12	80
	20.0-27.9	4	10	7	19	30	24	97
	28.0+	0	0	0	49	38	86	175
Total		59	75	70	218	168	147	739
Partial cut	3.1-3.9	2	0	0	0	0	0	3
	4.0-4.9	8	9	8	17	4	0	48
	5.0-5.9	0	1	0	5	2	0	10
	6.0-6.9	6	8	2	14	11	1	45
	7.0-7.9	0	0	1	3	2	0	8
	8.0-11.9	13	13	6	40	31	7	111
	12.0-15.9	12	7	6	27	20	8	83
	16.0-19.9	1	0	0	34	4	1	42
	20.0-27.9	5	4	7	21	18	9	65
	28.0+	0	0	0	29	31	29	91
Total		50	48	33	194	126	57	510

See footnotes at end of table.

Table 23—Gross volume (wood only) of live logging residue, for softwoods, by large-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Cubic feet per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	3	0	0	0	0	0	5
	4.0-4.9	14	10	6	11	2	0	44
	5.0-5.9	1	2	0	5	0	0	11
	6.0-6.9	8	8	7	25	8	0	57
	7.0-7.9	0	1	0	3	1	0	7
	8.0-11.9	11	12	7	32	26	5	95
	12.0-15.9	6	1	13	8	7	0	37
	16.0-19.9	5	8	2	4	2	2	25
	20.0-27.9	4	9	4	17	0	8	43
	28.0+	0	0	0	0	16	13	29
Total		55	55	42	109	65	30	358
Partial cut	3.1-3.9	6	1	0	0	0	0	8
	4.0-4.9	11	11	8	10	1	0	43
	5.0-5.9	1	1	1	4	1	0	10
	6.0-6.9	5	5	2	13	4	0	31
	7.0-7.9	0	2	1	2	2	0	8
	8.0-11.9	4	10	6	19	5	2	49
	12.0-15.9	9	3	5	7	6	4	36
	16.0-19.9	10	8	5	7	1	0	34
	20.0-27.9	0	0	8	2	4	4	19
	28.0+	20	11	0	8	21	18	80
Total		71	56	40	75	49	31	323
Private ^{2/}	3.1-3.9	6	3	0	0	0	0	10
	4.0-4.9	12	12	6	12	1	0	45
	5.0-5.9	0	2	2	6	1	0	13
	6.0-6.9	6	10	9	15	9	0	52
	7.0-7.9	0	1	2	5	3	0	13
	8.0-11.9	12	8	12	43	39	4	120
	12.0-15.9	6	7	6	16	18	5	62
	16.0-19.9	16	0	8	12	1	5	44
	20.0-27.9	14	7	15	6	10	10	64
	28.0+	0	0	0	0	6	0	7
Total		76	52	66	119	92	28	434
Ponderosa pine ^{3/}	3.1-3.9	4	1	0	0	0	0	6
	4.0-4.9	8	7	3	3	0	0	23
	5.0-5.9	1	1	1	2	0	0	6
	6.0-6.9	2	2	2	6	5	0	20
	7.0-7.9	0	0	0	2	1	0	5
	8.0-11.9	11	8	5	19	18	0	63
	12.0-15.9	3	6	9	8	4	1	34
	16.0-19.9	5	0	8	4	8	3	31
	20.0-27.9	14	11	0	12	3	0	41
	28.0+	0	7	0	5	3	0	17
Total		52	47	31	66	46	6	251

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 24—Number of live pieces of logging residue per acre, by small-end diameter and length classes, by stratum^{1/}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	17.3	21.9	16.2	39.4	23.8	8.2	126.8
	4.0-4.9	10.6	9.0	6.1	11.0	5.4	1.6	43.7
	5.0-5.9	.8	1.1	1.1	2.0	1.2	.2	6.4
	6.0-6.9	4.8	2.8	2.0	5.8	3.0	1.2	19.6
	7.0-7.9	.3	.3	.5	.5	.5	0	2.0
	8.0-11.9	2.2	2.3	2.0	3.4	2.8	.6	13.4
	12.0-15.9	.8	.3	.8	2.8	.6	.2	5.4
	16.0-19.9	.2	.3	.3	.6	.3	.2	1.9
	20.0-27.9	.3	.2	.8	.3	.6	0	2.2
	28.0+	.3	.2	0	0	.5	0	.9
Total		37.5	38.4	29.7	65.8	38.7	12.1	222.3
Partial cut	3.1-3.9	8.4	8.5	10.0	16.2	8.4	3.3	54.8
	4.0-4.9	7.2	5.2	2.7	8.2	2.7	.5	26.4
	5.0-5.9	.8	.5	0	1.5	.8	.2	3.8
	6.0-6.9	2.0	1.8	2.3	2.8	.5	.3	9.9
	7.0-7.9	.3	0	.2	.3	.2	0	1.0
	8.0-11.9	1.0	.3	1.3	2.0	1.2	.2	6.0
	12.0-15.9	1.3	.3	0	.2	.3	.2	2.3
	16.0-19.9	.3	.5	.3	.3	.2	0	1.7
	20.0-27.9	.2	0	0	0	0	0	.2
	28.0+	.2	0	0	.2	.2	.2	.7
Total		21.7	17.2	16.9	31.7	14.4	4.8	106.8
Private--								
Clearcut	3.1-3.9	14.4	18.6	19.0	51.6	40.8	13.1	157.5
	4.0-4.9	10.8	8.2	6.0	23.1	19.5	3.2	70.8
	5.0-5.9	.9	1.2	1.9	5.1	2.6	.7	13.8
	6.0-6.9	3.7	2.1	3.0	11.0	7.3	2.3	29.4
	7.0-7.9	0	.9	0	.9	.4	.2	2.3
	8.0-11.9	1.6	3.5	2.1	8.9	5.9	1.2	23.2
	12.0-15.9	.9	.4	.9	1.8	1.8	.7	6.4
	16.0-19.9	.4	.7	.4	1.2	.9	.2	3.7
	20.0-27.9	.2	.4	.2	0	.2	1.1	2.0
	28.0+	0	0	0	.5	.5	.7	1.8
Total		32.8	36.0	33.2	102.9	79.3	23.4	307.5
Partial cut	3.1-3.9	6.8	8.2	9.8	29.9	20.1	5.1	80.0
	4.0-4.9	7.5	8.6	4.7	16.8	9.1	1.8	48.5
	5.0-5.9	.9	1.2	.7	3.5	1.1	0	7.4
	6.0-6.9	2.1	3.0	2.1	7.2	4.2	.7	19.3
	7.0-7.9	0	.2	.2	0	.4	0	.7
	8.0-11.9	2.3	2.8	1.4	6.3	2.3	1.8	16.8
	12.0-15.9	1.2	.9	.4	2.3	1.4	.2	6.3
	16.0-19.9	0	0	.4	1.6	.7	.4	3.0
	20.0-27.9	.2	.2	0	.5	0	0	.9
	28.0+	0	0	.2	.4	.2	.2	.9
Total		21.0	25.0	19.8	68.4	39.4	10.0	183.6

See footnotes at end of table.

Table 24—Number of live pieces of logging residue per acre, by small-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	13.0	11.5	7.9	25.1	12.0	1.3	70.9
	4.0-4.9	8.7	5.3	4.6	11.4	3.0	.2	33.1
	5.0-5.9	.3	1.2	.5	1.5	.3	.2	4.0
	6.0-6.9	2.5	2.3	2.0	3.8	2.0	.5	13.0
	7.0-7.9	0	.3	.2	.2	.2	0	.8
	8.0-11.9	2.1	1.0	.8	2.3	1.0	.5	7.8
	12.0-15.9	.5	.2	1.0	.8	.3	.2	3.0
	16.0-19.9	.2	.3	.2	.2	.2	0	1.0
	20.0-27.9	.2	.3	.2	.3	0	0	1.0
	28.0+	0	0	0	0	.2	.2	.3
Total		27.5	22.4	17.3	45.5	19.1	3.0	134.9
Partial cut	3.1-3.9	12.4	10.5	9.8	18.4	7.5	.7	59.3
	4.0-4.9	7.6	5.8	3.2	5.6	2.3	.4	24.9
	5.0-5.9	1.0	1.4	.4	1.4	.1	0	4.5
	6.0-6.9	1.3	1.2	1.2	2.6	.7	.4	7.3
	7.0-7.9	.1	.3	0	0	0	0	.4
	8.0-11.9	1.0	1.7	.7	1.6	.3	.3	5.6
	12.0-15.9	1.0	0	.7	.7	.1	0	2.6
	16.0-19.9	.3	.4	0	.4	0	0	1.2
	20.0-27.9	.1	0	.3	0	.3	0	.7
	28.0+	.1	.1	0	.1	.1	.1	.7
Total		25.1	21.5	16.3	31.0	11.5	2.0	107.3
Private ^{2/}	3.1-3.9	13.7	13.9	9.3	21.0	12.3	3.2	73.3
	4.0-4.9	7.5	5.8	4.7	10.5	5.4	.6	34.4
	5.0-5.9	.3	1.4	1.1	1.8	2.5	.3	7.3
	6.0-6.9	2.2	2.8	3.6	4.8	3.7	1.2	18.4
	7.0-7.9	.4	.6	.7	1.8	.7	0	4.1
	8.0-11.9	2.1	1.4	1.2	5.2	2.5	.7	13.1
	12.0-15.9	.6	.7	.6	1.0	.4	0	3.2
	16.0-19.9	.8	.1	.4	.4	.1	.4	2.3
	20.0-27.9	.4	.1	.4	.1	.4	0	1.5
	28.0+	0	0	0	0	0	0	0
Total		27.9	26.8	22.0	46.7	28.0	6.4	157.7
Ponderosa pine ^{3/}	3.1-3.9	10.9	8.1	5.0	9.0	7.1	.6	40.7
	4.0-4.9	3.9	3.1	1.9	2.3	1.2	0	12.4
	5.0-5.9	.2	.6	.3	.5	.3	0	1.9
	6.0-6.9	1.1	.8	.6	1.2	.9	0	4.7
	7.0-7.9	.5	.3	0	.2	.2	0	1.1
	8.0-11.9	1.9	1.2	.8	2.6	.5	.3	7.3
	12.0-15.9	.3	.5	.6	.5	.5	0	2.3
	16.0-19.9	.3	0	.5	.2	.5	0	1.4
	20.0-27.9	.5	.5	0	.6	0	0	1.6
	28.0+	0	0	0	0	0	0	0
Total		19.4	15.1	9.6	17.1	11.2	.9	73.3

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 25—Number of pieces of logging residue per acre for softwoods, by small-end diameter and length classes, by stratum^{1/}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	38.3	32.6	22.1	45.8	17.6	2.8	159.3
	4.0-4.9	30.8	16.9	9.4	15.4	4.9	.8	78.0
	5.0-5.9	2.6	1.7	1.5	3.4	.8	0	9.9
	6.0-6.9	11.8	5.4	3.0	10.3	2.4	.6	33.6
	7.0-7.9	.9	.6	.6	.6	.6	0	3.2
	8.0-11.9	7.5	6.0	4.3	8.6	3.6	2.1	32.1
	12.0-15.9	2.4	1.3	2.4	6.4	1.9	.8	15.2
	16.0-19.9	1.7	1.1	1.3	3.9	2.3	.2	10.5
	20.0-27.9	.9	1.1	1.9	2.1	1.5	.9	8.4
	28.0+	.4	.4	0	.6	1.3	.2	2.3
Total		97.4	67.2	46.5	97.0	36.8	3.3	353.0
Partial cut	3.1-3.9	27.1	19.8	17.9	32.4	18.5	5.1	120.9
	4.0-4.9	25.4	16.0	8.3	18.1	6.4	1.3	75.5
	5.0-5.9	1.7	1.1	1.3	3.4	1.1	.2	8.7
	6.0-6.9	6.8	6.0	4.1	7.9	3.4	.6	28.8
	7.0-7.9	.2	0	.2	.9	.4	.2	1.9
	8.0-11.9	5.8	3.0	4.5	9.6	7.2	.9	30.9
	12.0-15.9	2.8	1.5	1.3	3.2	3.2	1.7	13.6
	16.0-19.9	1.1	1.5	1.1	1.5	1.7	1.7	8.5
	20.0-27.9	.2	.6	.2	1.3	.9	.6	3.8
	28.0+	.4	0	0	1.1	.4	.6	2.6
Total		71.4	49.5	38.8	79.3	43.3	13.0	295.3
Private--								
Clearcut	3.1-3.9	15.2	20.5	17.1	33.9	19.1	4.6	115.4
	4.0-4.9	16.1	9.9	8.3	17.1	11.7	.7	63.8
	5.0-5.9	1.4	1.6	1.6	4.2	1.1	.4	10.2
	6.0-6.9	7.2	4.4	3.9	11.0	3.9	.7	31.1
	7.0-7.9	.4	.9	.5	.9	.9	0	3.5
	8.0-11.9	4.2	6.5	7.2	11.5	6.4	1.6	37.5
	12.0-15.9	1.9	1.4	2.5	6.0	3.0	.7	15.5
	16.0-19.9	.5	1.6	1.4	3.7	2.3	.4	9.9
	20.0-27.9	1.1	1.6	.7	2.6	2.8	1.9	10.8
	28.0+	.2	0	.2	1.9	2.5	1.6	6.4
Total		48.2	48.4	43.5	97.9	53.5	12.5	304.0
Partial cut	3.1-3.9	11.2	11.4	10.2	28.2	15.0	2.3	78.3
	4.0-4.9	14.3	13.7	6.4	19.1	7.9	1.2	62.6
	5.0-5.9	1.2	1.2	1.5	3.0	.8	.2	7.7
	6.0-6.9	4.6	5.3	3.6	9.9	4.3	.5	28.2
	7.0-7.9	0	.3	.3	.7	.2	0	1.5
	8.0-11.9	5.6	6.3	3.3	10.9	4.9	1.5	32.5
	12.0-15.9	1.6	2.0	1.3	4.8	3.0	.7	13.3
	16.0-19.9	.7	1.5	1.8	4.6	2.8	1.2	12.5
	20.0-27.9	.7	.7	.2	2.6	2.8	.8	7.7
	28.0+	0	0	1.2	2.8	2.1	1.2	7.3
Total		39.9	42.2	29.8	86.5	43.8	9.4	251.7

See footnotes at end of table.

Table 25—Number of pieces of logging residue per acre for softwoods, by small-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	- - - - -	- - - - -	Number of pieces per acre		- - - - -	- - - - -	
Interior: Public-- Clearcut	3.1-3.9	23.2	16.8	9.8	30.2	15.4	1.4	96.8
	4.0-4.9	19.8	8.8	7.1	16.1	5.5	1.1	58.4
	5.0-5.9	.5	1.4	.7	2.5	1.3	.2	6.6
	6.0-6.9	6.6	5.7	4.5	7.7	2.9	.7	28.0
	7.0-7.9	0	.4	.4	.5	.2	0	1.4
	8.0-11.9	4.6	3.9	2.1	7.1	1.8	.9	20.5
	12.0-15.9	1.3	.5	2.5	4.3	1.4	.5	10.5
	16.0-19.9	.4	.5	1.1	1.3	1.8	0	5.0
	20.0-27.9	.4	.4	.4	.9	1.4	.2	3.6
	28.0+	0	0	0	.4	1.4	.9	2.7
Total		56.8	38.4	28.6	70.9	33.0	5.9	233.6
Partial cut	3.1-3.9	31.6	24.4	17.9	34.7	11.5	1.8	121.9
	4.0-4.9	25.2	12.5	7.0	12.5	5.5	1.4	64.0
	5.0-5.9	1.8	1.9	1.2	1.9	.4	.2	7.4
	6.0-6.9	7.0	4.9	3.9	6.6	1.9	1.0	25.3
	7.0-7.9	.2	.6	.8	.2	0	0	1.8
	8.0-11.9	4.5	4.1	2.9	7.6	3.7	1.4	24.2
	12.0-15.9	2.1	.8	1.4	3.9	2.3	.8	11.3
	16.0-19.9	.8	1.4	.8	2.5	1.4	.6	7.4
	20.0-27.9	.2	.2	.4	1.4	2.1	.4	5.7
	28.0+	.2	.4	.2	1.6	.6	1.4	4.3
Total		73.5	51.1	36.5	72.9	29.4	9.7	273.2
Private ^{2/}	3.1-3.9	24.6	22.1	12.2	31.8	16.9	2.6	110.2
	4.0-4.9	20.1	12.5	8.7	17.0	9.6	1.0	68.9
	5.0-5.9	1.2	2.0	1.7	3.2	2.6	.4	11.2
	6.0-6.9	8.6	6.4	5.4	8.4	6.1	1.2	36.1
	7.0-7.9	.7	.9	1.0	2.8	1.0	0	6.4
	8.0-11.9	5.8	4.2	4.8	10.2	4.5	1.5	31.0
	12.0-15.9	1.2	1.5	1.3	3.3	2.9	.7	10.9
	16.0-19.9	1.3	.6	.7	2.9	1.6	1.2	8.3
	20.0-27.9	.6	.4	.9	1.7	1.5	.9	6.0
	28.0+	.1	.1	0	.7	.9	.7	2.6
Total		64.1	50.8	36.8	82.2	47.6	10.2	291.6
Ponderosa pine ^{3/}	3.1-3.9	27.6	15.9	11.2	20.2	13.0	2.2	90.1
	4.0-4.9	16.8	8.3	4.0	8.1	1.9	.5	39.5
	5.0-5.9	1.4	.9	1.0	1.0	.5	0	4.8
	6.0-6.9	4.3	3.1	1.7	5.0	2.8	1.2	18.1
	7.0-7.9	.5	.7	.2	.3	.2	0	1.9
	8.0-11.9	5.5	5.7	2.1	8.8	3.6	1.9	27.6
	12.0-15.9	.9	1.0	1.6	4.1	2.2	.5	10.4
	16.0-19.9	.7	.3	1.0	2.9	1.7	1.7	8.5
	20.0-27.9	.5	.5	.5	1.9	2.4	1.0	6.9
	28.0+	0	0	0	.2	.3	.3	.9
Total		58.2	36.4	23.3	52.7	28.7	9.5	208.8

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 26—Number of live pieces of logging residue per acre for softwoods, by small-end diameter and length classes, by stratum^{1/}

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	15.9	18.2	13.4	29.4	12.0	1.6	90.4
	4.0-4.9	10.3	8.2	5.6	8.7	3.4	.6	36.9
	5.0-5.9	.6	.9	1.1	1.6	.5	0	4.7
	6.0-6.9	4.5	2.5	1.6	4.4	1.4	.5	14.8
	7.0-7.9	.3	.3	.5	.3	.5	0	1.9
	8.0-11.9	1.7	2.2	1.9	2.5	1.4	.3	10.0
	12.0-15.9	.8	.3	.8	2.3	.5	0	4.7
	16.0-19.9	.2	.3	.3	.6	.3	0	1.7
	20.0-27.9	.3	.2	.8	.3	.5	0	2.0
28.0+	.3	.2	0	0	.5	0	.9	
Total		34.8	33.3	25.8	50.1	20.8	3.0	167.9
Partial cut	3.1-3.9	7.4	7.7	8.7	13.0	6.5	2.5	45.8
	4.0-4.9	6.9	4.7	2.3	6.5	2.2	.3	22.9
	5.0-5.9	.8	.3	0	1.5	.7	0	3.3
	6.0-6.9	1.8	1.7	2.2	2.3	.5	.2	8.7
	7.0-7.9	.2	0	0	.3	.2	0	.7
	8.0-11.9	1.0	.3	1.3	1.7	1.0	.2	5.5
	12.0-15.9	1.2	.2	0	.2	.3	.2	2.0
	16.0-19.9	.3	.5	.3	.3	.2	0	1.7
	20.0-27.9	.2	0	0	0	0	0	.2
	28.0+	.2	0	0	.2	.2	.2	.7
Total		19.9	15.4	14.9	26.1	11.7	3.5	91.4
Private--								
Clearcut	3.1-3.9	9.2	13.3	13.7	30.2	17.9	4.3	88.5
	4.0-4.9	8.9	5.3	4.6	12.6	8.7	.7	40.8
	5.0-5.9	.9	1.1	1.4	3.5	.9	.4	8.2
	6.0-6.9	3.0	2.0	2.5	6.0	2.1	.4	16.0
	7.0-7.9	0	.5	0	.5	.4	0	1.4
	8.0-11.9	1.4	3.2	2.1	5.9	2.8	.9	16.3
	12.0-15.9	.9	.4	.9	1.4	.7	.5	4.8
	16.0-19.9	.4	.5	.4	1.1	.9	.2	3.4
	20.0-27.9	.2	.4	.2	0	.2	1.1	2.0
	28.0+	0	0	0	.5	.5	.7	1.8
Total		24.8	26.6	25.7	61.7	35.1	9.0	183.0
Partial cut	3.1-3.9	5.6	6.7	7.7	20.8	13.5	2.5	56.7
	4.0-4.9	6.7	7.9	2.6	12.6	5.6	.7	36.1
	5.0-5.9	.7	.7	.7	2.8	.9	0	5.8
	6.0-6.9	2.1	2.8	1.6	5.1	3.2	.2	14.9
	7.0-7.9	0	0	.2	0	.2	0	.4
	8.0-11.9	2.3	2.5	.7	4.9	1.8	.9	13.0
	12.0-15.9	1.2	.5	.4	1.4	1.1	.2	4.7
	16.0-19.9	0	0	.4	1.2	.5	.4	2.5
	20.0-27.9	.2	.2	0	.5	0	0	.9
	28.0+	0	0	0	.4	.2	.2	.7
Total		18.7	21.2	14.2	49.7	26.8	4.9	135.5

See footnotes at end of table.

Table 26—Number of live pieces of logging residue per acre for softwoods, by small-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Small-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	12.5	10.6	6.9	24.4	11.7	1.3	67.4
	4.0-4.9	8.2	5.3	4.1	10.7	3.0	.2	31.5
	5.0-5.9	.2	1.2	.5	1.5	.3	.2	3.8
	6.0-6.9	2.5	2.3	2.0	3.6	2.0	.2	12.5
	7.0-7.9	0	.3	.2	.2	.2	0	.8
	8.0-11.9	2.1	1.0	.8	2.3	.5	.3	7.1
	12.0-15.9	.5	.2	1.0	.8	.2	.2	2.8
	16.0-19.9	.2	.3	0	.2	0	0	.7
	20.0-27.9	.2	.3	.2	.3	0	0	1.0
	28.0+	0	0	0	0	.2	.2	.3
Total		26.4	21.4	15.7	44.0	18.0	2.5	128.0
Partial cut	3.1-3.9	12.0	10.5	9.4	17.6	6.8	.7	56.9
	4.0-4.9	7.6	5.8	3.2	5.6	2.2	.4	24.8
	5.0-5.9	1.0	1.4	.4	1.4	.1	0	4.5
	6.0-6.9	1.3	1.2	1.2	2.6	.7	.4	7.3
	7.0-7.9	.1	.3	0	0	0	0	.4
	8.0-11.9	1.0	1.7	.7	1.4	.3	.3	5.5
	12.0-15.9	1.0	0	.7	.7	.1	0	2.6
	16.0-19.9	.3	.4	0	.4	0	0	1.2
	20.0-27.9	.1	0	.3	0	.3	0	.7
	28.0+	.1	.1	0	.1	.1	.1	.7
Total		24.6	21.5	15.8	30.0	10.7	2.0	104.5
Private ^{2/}	3.1-3.9	13.1	13.4	8.4	19.7	10.4	2.1	67.1
	4.0-4.9	7.3	5.8	4.6	9.9	5.2	.3	33.1
	5.0-5.9	.3	1.2	1.1	1.8	2.5	.3	7.2
	6.0-6.9	2.2	2.6	3.5	4.4	3.2	.7	16.6
	7.0-7.9	.4	.6	.7	1.8	.7	0	4.1
	8.0-11.9	2.1	1.4	1.2	5.1	2.2	.6	12.6
	12.0-15.9	.6	.7	.6	1.0	.4	0	3.2
	16.0-19.9	.8	.1	.4	.4	.1	.4	2.3
	20.0-27.9	.4	.1	.4	.1	.4	0	1.5
	28.0+	0	0	0	0	0	0	0
Total		27.2	26.0	20.8	44.3	25.1	4.3	147.7
Ponderosa pine ^{3/}	3.1-3.9	10.9	8.1	5.0	9.0	7.1	.6	40.7
	4.0-4.9	3.9	3.1	1.9	2.3	1.2	0	12.4
	5.0-5.9	.2	.6	.3	.5	.3	0	1.9
	6.0-6.9	1.1	.8	.6	1.2	.9	0	4.7
	7.0-7.9	.5	.3	0	.2	.2	0	1.1
	8.0-11.9	1.9	1.2	.8	2.6	.5	.3	7.3
	12.0-15.9	.3	.5	.6	.5	.5	0	2.3
	16.0-19.9	.3	0	.5	.2	.5	.2	1.4
	20.0-27.9	.5	.5	0	.6	0	0	1.6
	28.0+	0	0	0	0	0	0	0
Total		19.4	15.1	9.6	17.1	11.2	.9	73.3

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 27—Number of pieces of logging residue per acre, by large-end diameter and length classes, by stratum^{1/}

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	17.8	7.9	4.7	1.9	0.2	0	32.5
	4.0-4.9	43.3	33.0	21.2	32.3	5.8	.4	136.0
	5.0-5.9	5.8	6.4	3.9	15.2	3.9	.6	35.8
	6.0-6.9	16.5	12.2	7.9	21.4	12.4	.4	70.7
	7.0-7.9	.4	1.5	.8	3.2	2.4	.2	3.4
	8.0-11.9	12.2	8.4	6.2	22.9	20.4	8.1	78.2
	12.0-15.9	3.4	2.3	3.0	11.1	4.9	4.1	28.7
	16.0-19.9	2.4	2.8	1.5	7.3	4.1	2.4	20.6
	20.0-27.9	1.1	1.7	2.4	3.4	3.0	1.7	13.3
	28.0+	.6	.4	.6	.8	2.4	1.5	6.2
Total		103.5	76.5	52.1	119.3	59.7	19.3	430.5
Partial cut	3.1-3.9	11.5	3.4	2.6	2.3	0	0	19.8
	4.0-4.9	36.0	26.0	19.0	22.8	6.8	.4	111.1
	5.0-5.9	2.8	3.2	2.6	10.2	5.5	.6	24.9
	6.0-6.9	11.3	10.0	8.7	20.7	10.2	1.7	62.7
	7.0-7.9	.2	1.3	.9	3.4	1.3	.4	7.5
	8.0-11.9	9.0	6.4	6.0	23.2	13.9	3.6	62.0
	12.0-15.9	3.6	1.5	2.8	7.5	6.4	2.6	24.3
	16.0-19.9	1.7	2.1	1.1	2.3	3.8	1.3	12.4
	20.0-27.9	.2	.9	.9	2.6	1.9	1.9	8.3
	28.0+	.4	0	0	1.3	.9	2.3	4.9
Total		76.7	54.8	44.3	96.4	50.7	14.9	337.9
Private--								
Clearcut	3.1-3.9	7.9	4.1	3.5	2.6	.7	0	18.9
	4.0-4.9	26.1	26.3	16.4	33.2	10.8	.9	113.8
	5.0-5.9	2.6	3.5	3.9	16.1	7.3	.5	34.4
	6.0-6.9	9.4	8.5	8.5	36.2	18.2	2.3	83.0
	7.0-7.9	.5	1.6	1.2	4.9	3.5	.5	12.4
	8.0-11.9	7.6	11.3	12.0	30.2	36.2	11.0	108.3
	12.0-15.9	3.0	1.6	3.0	10.2	11.1	5.8	34.8
	16.0-19.9	.9	1.9	3.2	4.4	4.2	1.6	16.3
	20.0-27.9	1.1	2.6	1.2	5.7	4.9	1.8	17.3
	28.0+	.4	.2	.4	2.8	3.2	2.8	9.7
Total		59.5	61.7	53.4	146.5	100.7	27.2	448.9
Partial cut	3.1-3.9	4.1	2.0	1.5	.8	0	0	8.4
	4.0-4.9	19.4	19.1	15.0	28.8	7.9	0	90.3
	5.0-5.9	1.3	3.1	2.0	7.3	3.1	.3	17.1
	6.0-6.9	7.6	8.6	4.6	18.5	12.4	1.3	52.9
	7.0-7.9	.2	1.2	.8	2.1	2.3	.5	7.1
	8.0-11.9	8.4	8.2	7.4	25.5	15.5	5.1	70.2
	12.0-15.9	1.8	2.6	2.3	9.9	5.9	2.5	25.1
	16.0-19.9	.8	1.8	1.3	5.8	3.3	1.3	14.3
	20.0-27.9	.7	1.3	1.2	5.8	5.1	1.2	15.2
	28.0+	0	.5	1.3	3.6	4.0	2.3	11.7
Total		44.3	48.5	37.4	108.1	59.5	14.5	312.3

See footnotes at end of table.

Table 27—Number of pieces of logging residue per acre, by large-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Interior: Public--								
Clearcut	3.1-3.9	7.5	2.3	1.1	0.9	0.2	0	12.0
	4.0-4.9	30.5	17.0	12.0	18.0	3.0	0	80.6
	5.0-5.9	2.1	3.2	1.1	6.4	.9	0	13.8
	6.0-6.9	10.4	8.0	6.1	21.3	7.7	.4	53.8
	7.0-7.9	.2	.5	.4	2.3	1.6	.4	5.4
	8.0-11.9	6.6	6.4	4.8	14.8	11.4	2.1	46.3
	12.0-15.9	2.0	1.6	2.9	6.3	3.6	.5	16.8
	16.0-19.9	.5	1.1	1.3	2.3	1.6	1.4	8.2
	20.0-27.9	.4	.4	1.1	2.5	2.7	.5	7.5
	28.0+	0	0	0	.5	1.8	1.1	3.4
Total		60.2	40.5	30.5	75.4	34.5	6.4	247.6
Partial cut	3.1-3.9	17.0	5.8	1.4	.4	0	0	24.6
	4.0-4.9	35.1	24.6	17.0	20.7	3.1	0	100.4
	5.0-5.9	2.1	2.9	2.7	7.8	2.5	0	18.1
	6.0-6.9	10.1	6.0	4.9	16.2	5.8	.4	43.5
	7.0-7.9	0	1.4	1.8	2.9	1.4	.2	7.6
	8.0-11.9	6.2	7.8	6.4	15.0	6.8	2.1	44.5
	12.0-15.9	2.3	1.4	1.8	5.1	3.9	1.4	15.8
	16.0-19.9	1.2	1.6	1.4	2.3	2.9	.4	9.7
	20.0-27.9	0	.2	.4	2.9	2.7	2.7	9.0
	28.0+	.4	.4	.2	1.8	1.9	2.7	7.4
Total		74.5	52.1	37.8	75.1	31.2	9.9	280.6
Private ^{2/}	3.1-3.9	13.8	5.1	1.2	.9	0	0	20.9
	4.0-4.9	27.0	23.1	11.5	21.7	3.1	.3	86.7
	5.0-5.9	1.3	3.3	4.1	9.7	2.2	.1	20.8
	6.0-6.9	11.5	10.2	9.2	16.6	11.9	.6	59.9
	7.0-7.9	.7	1.2	1.2	3.8	2.8	.3	9.9
	8.0-11.9	7.9	6.3	7.3	19.6	18.5	3.9	63.4
	12.0-15.9	1.7	1.7	2.3	6.3	6.3	2.3	20.6
	16.0-19.9	1.5	.7	1.3	3.5	2.8	.9	10.6
	20.0-27.9	.6	.7	1.0	2.8	2.5	2.3	9.9
	28.0+	.1	.3	.1	1.0	1.9	1.7	5.2
Total		66.2	52.6	39.1	85.8	51.8	12.5	308.0
Ponderosa pine ^{3/}	3.1-3.9	11.6	2.1	.7	.2	.2	.2	14.9
	4.0-4.9	26.2	15.4	8.5	9.3	1.6	0	61.0
	5.0-5.9	2.8	1.7	2.1	4.8	1.2	0	12.6
	6.0-6.9	7.8	5.7	4.1	9.7	5.5	.2	33.0
	7.0-7.9	.2	.9	.7	2.1	1.6	.5	5.9
	8.0-11.9	7.1	7.1	3.5	14.2	7.6	.9	40.2
	12.0-15.9	1.4	2.4	2.2	5.9	3.8	.9	16.6
	16.0-19.9	.7	.9	.9	3.5	2.1	2.2	10.2
	20.0-27.9	.5	.5	.7	2.4	2.9	2.6	9.7
	28.0+	0	.2	0	1.0	2.2	2.1	5.5
Total		58.2	36.8	23.3	53.0	28.7	9.5	209.5

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 28—Number of live pieces of logging residue per acre, by large-end diameter and length classes, by stratum^{1/}

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Coastal: Public-- Clearcut	3.1-3.9	6.8	4.2	2.8	0.8	0	0	14.6
	4.0-4.9	16.5	19.0	13.8	21.9	4.0	.3	75.6
	5.0-5.9	3.0	3.0	2.3	10.4	2.8	.5	21.9
	6.0-6.9	5.3	5.8	4.4	13.1	9.0	.3	37.8
	7.0-7.9	0	.6	.6	2.0	1.9	0	5.1
	8.0-11.9	3.7	3.6	3.3	11.0	15.1	6.1	42.8
	12.0-15.9	1.1	.9	.9	4.0	2.6	3.3	12.9
	16.0-19.9	.5	1.1	.3	1.7	1.9	1.2	6.7
	20.0-27.9	.3	.2	.8	.6	.6	.2	2.6
	28.0+	.3	.2	.5	.2	.8	.3	2.2
Total		37.5	38.4	29.7	65.8	38.7	12.1	222.3
Partial cut	3.1-3.9	4.0	1.8	1.0	1.3	0	0	8.2
	4.0-4.9	9.9	8.7	8.5	7.9	2.3	.2	37.4
	5.0-5.9	.7	1.2	1.2	5.7	1.3	.2	10.2
	6.0-6.9	2.5	3.3	3.0	7.0	4.3	.8	21.1
	7.0-7.9	0	.2	.2	1.2	.5	.3	2.3
	8.0-11.9	2.5	1.0	2.2	7.0	4.5	1.3	18.5
	12.0-15.9	1.3	.3	.5	1.2	.8	1.3	5.5
	16.0-19.9	.5	.5	.3	0	.3	.5	2.2
	20.0-27.9	.2	.2	0	.3	0	0	.7
	28.0+	.2	0	0	.2	.2	.2	.7
Total		21.7	17.2	16.9	31.7	14.4	4.8	106.8
Private-- Clearcut	3.1-3.9	3.9	2.8	3.0	2.1	.4	0	12.2
	4.0-4.9	17.0	18.1	11.7	26.1	9.4	.7	83.0
	5.0-5.9	1.4	2.7	2.7	13.8	7.3	.5	28.4
	6.0-6.9	4.4	4.8	7.1	28.9	16.8	2.1	64.2
	7.0-7.9	.2	1.1	.7	4.6	3.0	.5	10.1
	8.0-11.9	3.7	4.6	5.9	19.9	31.0	10.8	75.9
	12.0-15.9	1.6	.4	1.1	4.3	6.7	5.0	19.0
	16.0-19.9	.4	.9	.7	1.6	2.7	1.4	7.6
	20.0-27.9	.2	.5	.2	1.1	1.4	.9	4.3
	28.0+	0	.2	.2	.5	.5	1.4	2.8
Total		32.8	36.0	33.2	102.9	79.3	23.4	307.5
Partial cut	3.1-3.9	2.3	.7	1.1	.4	0	0	4.4
	4.0-4.9	9.5	11.9	11.2	23.8	6.5	0	62.8
	5.0-5.9	.4	1.4	.5	5.6	3.0	.4	11.2
	6.0-6.9	3.9	5.1	2.1	12.3	10.2	1.2	34.7
	7.0-7.9	0	.7	.7	1.6	2.1	.5	5.6
	8.0-11.9	3.5	3.7	2.8	16.1	12.8	4.9	43.8
	12.0-15.9	1.2	1.2	.9	4.6	2.8	1.8	12.4
	16.0-19.9	.2	0	0	2.8	.9	.5	4.4
	20.0-27.9	.2	.2	.4	.9	.9	.4	2.8
	28.0+	0	.2	.2	.5	.4	.4	1.6
Total		21.0	25.0	19.8	68.4	39.4	10.0	183.6

See footnotes at end of table.

Table 28—Number of live pieces of logging residue per acre, by large-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Interior: Public--								
Clearcut	3.1-3.9	4.0	0.8	0.7	0.8	0	0	6.3
	4.0-4.9	14.5	10.9	8.2	11.9	2.5	0	48.0
	5.0-5.9	1.3	2.0	.7	5.6	.7	0	10.2
	6.0-6.9	4.1	4.5	3.8	14.0	5.1	.3	31.8
	7.0-7.9	.2	.3	.3	1.6	1.0	.3	3.8
	8.0-11.9	2.3	3.0	1.8	9.6	7.8	1.2	25.6
	12.0-15.9	.7	.2	1.3	1.0	1.3	.2	4.6
	16.0-19.9	.3	.5	.2	.3	.3	.5	2.1
	20.0-27.9	.2	.3	.3	.7	.3	.3	2.1
	28.0+	0	0	0	0	.2	.2	.3
Total		27.5	22.4	17.3	45.5	19.1	3.0	134.9
Partial cut	3.1-3.9	6.5	1.6	.7	.1	0	0	8.9
	4.0-4.9	12.1	11.5	8.4	10.9	1.7	0	44.6
	5.0-5.9	.9	1.7	1.7	4.2	1.4	0	9.9
	6.0-6.9	2.7	2.4	1.6	7.5	3.5	.1	17.9
	7.0-7.9	0	.7	.9	1.4	1.0	0	4.0
	8.0-11.9	1.2	2.4	1.7	5.3	2.2	1.0	13.8
	12.0-15.9	.9	.4	.7	.7	1.0	.6	4.3
	16.0-19.9	.6	.4	.3	.4	.1	0	1.9
	20.0-27.9	0	0	.3	.1	.1	.1	.7
	28.0+	.3	.1	0	.1	.4	.1	1.2
Total		25.1	21.5	16.3	31.0	11.5	2.0	107.3
Private ^{2/}	3.1-3.9	6.9	3.3	.7	.4	0	0	11.3
	4.0-4.9	12.6	12.7	7.2	14.2	1.5	.1	48.3
	5.0-5.9	.3	2.2	2.8	6.1	1.8	.1	13.3
	6.0-6.9	3.0	5.1	5.2	9.5	6.8	.4	30.1
	7.0-7.9	.3	.6	1.0	2.3	2.1	.3	6.5
	8.0-11.9	3.0	1.9	3.0	11.0	11.7	2.8	33.6
	12.0-15.9	.6	.7	.8	2.1	3.2	1.5	8.8
	16.0-19.9	.8	0	.6	.7	.1	.7	2.9
	20.0-27.9	.4	.3	.6	.3	.6	.4	2.5
	28.0+	0	0	.1	0	.3	0	.4
Total		27.9	26.8	22.0	46.7	28.0	6.4	157.7
Ponderosa pine ^{3/}	3.1-3.9	5.0	1.1	.6	.2	0	0	6.8
	4.0-4.9	8.1	8.1	3.6	3.3	.9	0	23.9
	5.0-5.9	1.4	1.1	1.1	2.2	.3	0	6.1
	6.0-6.9	1.2	1.2	1.6	3.7	3.0	.2	10.9
	7.0-7.9	0	.3	.3	1.4	1.1	0	3.1
	8.0-11.9	2.6	2.0	1.1	4.5	4.5	.2	14.9
	12.0-15.9	.3	.8	.9	.9	.6	.2	3.7
	16.0-19.9	.3	0	.5	.3	.5	.3	1.9
	20.0-27.9	.5	.3	0	.5	.2	0	1.4
	28.0+	0	.2	0	.2	.2	.2	.6
Total		19.4	15.1	9.6	17.1	11.2	.9	73.3

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 29—Number of pieces of logging residue per acre for softwoods, by large-end diameter and length classes, by stratum^{1/}

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Coastal:								
Public--								
Clearcut	3.1-3.9	16.5	6.6	3.9	1.9	0.2	0	29.1
	4.0-4.9	40.7	29.5	18.6	27.0	4.5	.2	120.4
	5.0-5.9	5.6	4.7	3.4	11.6	3.2	.4	28.9
	6.0-6.9	15.6	10.5	7.1	16.3	7.9	0	57.4
	7.0-7.9	.4	1.1	.8	3.0	1.5	.2	6.9
	8.0-11.9	11.6	7.9	5.3	17.3	10.1	3.0	55.2
	12.0-15.9	3.0	2.1	3.0	9.0	1.7	.6	19.3
	16.0-19.9	2.4	2.8	1.5	6.9	2.6	1.3	17.6
	20.0-27.9	.9	1.7	2.4	3.2	2.6	1.5	12.4
	28.0+	.6	.4	.6	.8	2.4	1.1	5.8
Total		97.4	67.2	46.5	97.0	36.8	8.3	353.0
Partial cut	3.1-3.9	10.7	3.0	2.1	2.1	0	0	17.9
	4.0-4.9	33.7	23.7	16.2	19.8	6.2	.4	100.0
	5.0-5.9	2.6	2.6	2.1	8.3	4.9	.6	21.1
	6.0-6.9	10.7	9.8	8.3	16.4	9.2	1.3	55.6
	7.0-7.9	.2	1.1	.9	3.0	1.1	.2	6.4
	8.0-11.9	8.1	5.1	4.9	18.1	10.9	3.0	50.1
	12.0-15.9	3.2	1.5	2.6	6.2	5.3	1.9	20.7
	16.0-19.9	1.7	2.1	.9	1.7	3.2	1.3	10.9
	20.0-27.9	.2	.6	.9	2.3	1.7	1.9	7.7
	28.0+	.4	0	0	1.3	.9	2.3	4.9
Total		71.4	49.5	38.8	79.3	43.3	13.0	295.3
Private--								
Clearcut	3.1-3.9	7.2	3.2	2.5	1.9	.4	0	15.2
	4.0-4.9	18.5	19.4	12.0	20.8	5.5	.4	76.7
	5.0-5.9	2.3	2.3	2.8	11.0	4.1	.4	22.8
	6.0-6.9	8.3	6.5	7.2	21.9	7.8	1.4	53.2
	7.0-7.9	.5	1.1	.9	3.0	1.9	.2	7.6
	8.0-11.9	6.2	9.7	10.8	18.0	17.1	3.4	65.2
	12.0-15.9	2.8	1.6	2.8	8.8	6.4	1.8	24.2
	16.0-19.9	.9	1.9	3.0	4.2	2.6	.9	13.6
	20.0-27.9	1.1	2.5	1.1	5.5	4.6	1.4	16.1
	28.0+	.4	.2	.4	2.6	3.2	2.8	9.5
Total		48.2	48.4	43.5	97.9	53.5	12.5	304.0
Partial cut	3.1-3.9	3.8	1.8	1.0	.7	0	0	7.3
	4.0-4.9	17.0	16.6	11.7	22.2	5.9	0	73.5
	5.0-5.9	1.3	2.6	1.6	5.9	2.3	0	13.8
	6.0-6.9	6.4	7.1	3.3	13.3	8.2	.8	39.2
	7.0-7.9	0	1.0	.8	2.1	1.5	.2	5.6
	8.0-11.9	8.1	7.6	5.6	20.1	10.4	2.5	54.2
	12.0-15.9	1.8	2.1	2.1	8.6	4.6	1.5	20.8
	16.0-19.9	.8	1.6	1.3	4.8	2.3	1.0	11.9
	20.0-27.9	.7	1.2	1.2	5.3	4.9	1.2	14.3
	28.0+	0	.5	1.2	3.5	3.6	2.3	11.0
Total		39.9	42.2	29.8	86.5	43.8	9.4	251.7

See footnotes at end of table.

Table 29—Number of pieces of logging residue per acre for softwoods, by large-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	-	-	-	-	-	-	-
Interior: Public--		Number of pieces per acre						
Clearcut	3.1-3.9	6.8	2.1	1.1	0.9	0.2	0	11.1
	4.0-4.9	29.1	15.7	10.2	16.3	3.0	0	74.3
	5.0-5.9	1.6	3.2	1.1	6.4	.9	0	13.2
	6.0-6.9	10.0	7.3	6.1	19.8	7.5	.4	51.1
	7.0-7.9	.2	.5	.4	2.3	1.4	.4	5.2
	8.0-11.9	6.3	6.4	4.8	13.8	11.4	2.1	44.8
	12.0-15.9	2.0	1.6	2.9	6.1	3.2	.4	16.1
	16.0-19.9	.5	1.1	1.3	2.3	1.3	1.1	7.5
	20.0-27.9	.4	.4	.9	2.5	2.3	.5	7.0
	28.0+	0	0	0	.5	1.8	1.1	3.4
Total		56.8	38.4	28.6	70.9	33.0	5.9	233.6
Partial cut	3.1-3.9	16.6	5.7	1.4	.2	0	0	23.8
	4.0-4.9	34.9	24.2	16.6	20.3	3.1	0	99.1
	5.0-5.9	2.1	2.9	2.5	7.6	2.5	0	17.7
	6.0-6.9	9.9	6.0	4.7	15.4	5.1	.4	41.5
	7.0-7.9	0	1.4	1.6	2.9	1.4	.2	7.4
	8.0-11.9	6.2	7.4	6.0	14.4	6.0	2.1	42.3
	12.0-15.9	2.1	1.4	1.8	5.1	3.7	1.4	15.4
	16.0-19.9	1.2	1.6	1.4	2.3	2.9	.2	9.6
	20.0-27.9	0	.2	.4	2.9	2.7	2.7	9.0
	28.0+	.4	.4	.2	1.8	1.9	2.7	7.4
Total		73.5	51.1	36.5	72.9	29.4	9.7	273.2
Private ^{2/}	3.1-3.9	13.4	4.9	1.0	.9	0	0	20.2
	4.0-4.9	26.0	22.2	10.5	20.4	2.8	.3	82.2
	5.0-5.9	1.2	3.3	3.8	9.7	2.0	.1	20.2
	6.0-6.9	11.3	9.5	8.6	15.4	11.2	.6	56.6
	7.0-7.9	.7	1.2	1.2	3.8	2.8	.3	9.9
	8.0-11.9	7.7	6.3	7.1	18.8	17.0	2.6	59.5
	12.0-15.9	1.6	1.6	2.2	6.0	5.1	1.7	18.2
	16.0-19.9	1.5	.7	1.3	3.5	2.6	.6	10.2
	20.0-27.9	.6	.7	1.0	2.8	2.2	2.2	9.5
	28.0+	.1	.3	.1	1.0	1.9	1.7	5.2
Total		64.1	50.8	36.8	82.2	47.6	10.2	291.6
Ponderosa pine ^{3/}	3.1-3.9	11.6	2.1	.7	.2	.2	.2	14.9
	4.0-4.9	26.2	15.2	8.5	9.2	1.6	0	60.6
	5.0-5.9	2.8	1.7	2.1	4.7	1.2	0	12.4
	6.0-6.9	7.8	5.5	4.1	9.7	5.5	.2	32.8
	7.0-7.9	.2	.9	.7	2.1	1.6	.5	5.9
	8.0-11.9	7.1	7.1	3.5	14.2	7.6	.9	40.2
	12.0-15.9	1.4	2.4	2.2	5.9	3.8	.9	16.6
	16.0-19.9	.7	.9	.9	3.5	2.1	2.2	10.2
	20.0-27.9	.5	.5	.7	2.4	2.9	2.6	9.7
	28.0+	0	.2	0	1.0	2.2	2.1	5.5
Total		58.2	36.4	23.3	52.7	28.7	9.5	208.8

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 30—Number of live pieces of logging residue per acre for softwoods, by large-end diameter and length classes, by stratum¹

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Coastal:								
Public-- Clearcut	3.1-3.9	6.1	3.3	2.3	0.8	0	0	12.4
	4.0-4.9	15.9	16.8	12.0	18.0	3.0	.2	65.8
	5.0-5.9	2.8	2.3	1.9	7.6	2.3	.3	17.3
	6.0-6.9	4.8	4.7	3.7	9.2	5.4	0	27.8
	7.0-7.9	0	.6	.6	2.0	1.1	0	4.4
	8.0-11.9	3.4	3.3	2.8	7.3	6.7	1.9	25.4
	12.0-15.9	.8	.9	.9	3.0	.3	.3	6.2
	16.0-19.9	.5	1.1	.3	1.4	.8	.3	4.4
	20.0-27.9	.3	.2	.8	.6	.5	0	2.3
	28.0+	.3	.2	.5	.2	.8	0	1.9
Total		34.8	33.3	25.8	50.1	20.8	3.0	167.9
Partial cut	3.1-3.9	3.5	1.7	1.0	1.2	0	0	7.4
	4.0-4.9	9.0	7.7	7.4	6.9	1.8	.2	32.9
	5.0-5.9	.7	1.0	1.0	4.7	1.2	.2	8.7
	6.0-6.9	2.3	3.2	2.8	5.7	4.2	.5	18.7
	7.0-7.9	0	.2	.2	.8	.3	.2	1.7
	8.0-11.9	2.3	.8	1.7	5.5	3.3	.8	14.5
	12.0-15.9	1.2	.3	.5	.8	.3	1.0	4.2
	16.0-19.9	.5	.5	.3	0	.3	.5	2.2
	20.0-27.9	.2	0	0	.3	0	0	.5
	28.0+	.2	0	0	.2	.2	.2	.7
Total		19.9	15.4	14.9	26.1	11.7	3.5	91.4
Private-- Clearcut	3.1-3.9	3.4	2.3	2.0	1.6	0	0	9.2
	4.0-4.9	11.5	12.9	8.3	15.4	4.4	.2	52.9
	5.0-5.9	1.2	1.4	2.0	9.6	3.5	.4	18.1
	6.0-6.9	3.7	3.5	6.0	15.8	6.7	1.2	37.1
	7.0-7.9	.2	.9	.5	2.8	1.8	.2	6.4
	8.0-11.9	2.8	3.7	5.0	10.6	13.1	3.2	38.5
	12.0-15.9	1.4	.4	1.1	3.0	2.7	1.1	9.6
	16.0-19.9	.4	.9	.5	1.4	1.1	.7	5.0
	20.0-27.9	.2	.4	.2	.9	1.2	.7	3.5
	28.0+	0	.2	.2	.5	.5	1.4	2.8
Total		24.8	26.6	25.7	61.7	35.1	9.0	183.0
Partial cut	3.1-3.9	2.1	.7	.7	.2	0	0	3.7
	4.0-4.9	8.2	10.0	8.4	17.5	4.6	0	48.7
	5.0-5.9	.4	1.2	.5	4.6	2.1	0	8.8
	6.0-6.9	3.2	4.4	1.1	7.7	6.8	.9	24.0
	7.0-7.9	0	.5	.7	1.6	1.2	.2	4.2
	8.0-11.9	3.3	3.2	1.6	11.4	8.4	2.1	29.9
	12.0-15.9	1.2	.9	.9	3.5	2.1	.9	9.5
	16.0-19.9	.2	0	0	2.1	.4	.2	2.8
	20.0-27.9	.2	.2	.4	.7	.9	.4	2.6
	28.0+	0	.2	0	.5	.4	.4	1.4
Total		18.7	21.2	14.2	49.7	26.8	4.9	135.5

See footnotes at end of table.

Table 30—Number of live pieces of logging residue per acre for softwoods, by large-end diameter and length classes, by stratum^{1/} (continued)

Stratum	Large-end diameter	Length (feet)						Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	Inches	Number of pieces per acre						
Interior:								
Public--								
Clearcut	3.1-3.9	3.6	0.7	0.7	0.8	0	0	5.8
	4.0-4.9	14.2	10.2	6.8	11.2	2.5	0	44.9
	5.0-5.9	1.0	2.0	.7	5.6	.7	0	9.9
	6.0-6.9	4.0	4.3	3.8	13.7	4.9	.3	31.0
	7.0-7.9	.2	.3	.3	1.6	.8	.3	3.6
	8.0-11.9	2.3	3.0	1.8	9.1	7.8	1.2	25.1
	12.0-15.9	.7	.2	1.3	1.0	1.0	0	4.1
	16.0-19.9	.3	.5	.2	.3	.2	.2	1.6
	20.0-27.9	.2	.3	.2	.7	0	.3	1.6
	28.0+	0	0	0	0	.2	.2	.3
Total		26.4	21.4	15.7	44.0	18.0	2.5	128.0
Partial cut	3.1-3.9	6.2	1.6	.7	0	0	0	8.5
	4.0-4.9	12.0	11.5	8.2	10.7	1.7	0	44.1
	5.0-5.9	.9	1.7	1.6	4.0	1.4	0	9.6
	6.0-6.9	2.7	2.4	1.4	7.3	2.9	.1	17.0
	7.0-7.9	0	.7	.9	1.4	1.0	0	4.0
	8.0-11.9	1.2	2.4	1.7	5.0	1.9	1.0	13.2
	12.0-15.9	.9	.4	.7	.7	1.0	.6	4.3
	16.0-19.9	.6	.4	.3	.4	.1	0	1.9
	20.0-27.9	0	0	.3	.1	.1	.1	.7
	28.0+	.3	.1	0	.1	.4	.1	1.2
Total		24.6	21.5	15.8	30.0	10.7	2.0	104.5
Private ^{2/}	3.1-3.9	6.8	3.2	.6	.4	0	0	10.9
	4.0-4.9	12.2	12.3	6.6	13.1	1.2	.1	45.6
	5.0-5.9	.3	2.2	2.6	6.1	1.7	.1	13.0
	6.0-6.9	3.0	4.8	5.0	8.8	6.2	.4	28.3
	7.0-7.9	.3	.6	1.0	2.3	2.1	.3	6.5
	8.0-11.9	2.9	1.9	3.0	10.5	10.6	1.5	30.5
	12.0-15.9	.6	.7	.8	2.1	2.5	1.0	7.6
	16.0-19.9	.8	0	.6	.7	.1	.4	2.6
	20.0-27.9	.4	.3	.6	.3	.4	.4	2.3
	28.0+	0	0	.1	0	.3	0	.4
Total		27.2	26.0	20.8	44.3	25.1	4.3	147.7
Ponderosa pine ^{3/}	3.1-3.9	5.0	1.1	.6	.2	0	0	6.8
	4.0-4.9	8.1	8.1	3.6	3.3	.9	0	23.9
	5.0-5.9	1.4	1.1	1.1	2.2	.3	0	6.1
	6.0-6.9	1.2	1.2	1.6	3.7	3.0	.2	10.9
	7.0-7.9	0	.3	.3	1.4	1.1	0	3.1
	8.0-11.9	2.6	2.0	1.1	4.5	4.5	.2	14.9
	12.0-15.9	.3	.8	.9	.9	.6	.2	3.7
	16.0-19.9	.3	0	.5	.3	.5	.3	1.9
	20.0-27.9	.5	.3	0	.5	.2	0	1.4
	28.0+	0	.2	0	.2	.2	.2	.6
Total		19.4	15.1	9.6	17.1	11.2	.9	73.3

^{1/}Does not include residue in large piles.

^{2/}Samples were selected from all harvest methods; the majority of samples were from partial-cut areas.

^{3/}Samples were selected from all harvest methods and ownership classes.

Table 31—Average net volume (wood and bark) of logging residue, per thousand board feet of timber harvest; by area, owner class, and harvest method; in Idaho, Montana, Oregon, and Washington

Area and owner class	Harvest method	
	Clearcut	Partial cut
	Cubic feet per thousand board feet	
Idaho:		
National Forest	87	122
Other public	--	1/142
Private	--	<u>1/109</u>
Western Oregon:		
National Forest	47	2/136
Other public	52	93
Private	40	296
Western Washington		
National Forest	44	2/136
Other public	51	<u>118</u>
Private	37	140
Eastern Oregon		
Public	--	1/76
Private	--	<u>1/80</u>
Eastern Washington		
Public	--	1/96
Private	--	<u>1/72</u>
Montana:		
Public	95	103
Private	--	3/137
Lodgepole pine	--	<u>4/107</u>

-- = not applicable.

1/Samples selected randomly from all areas harvested since January 1, 1979; a large majority of samples were from partial-cut areas, the predominant practice in this stratum.

2/This figure represents an average of cutover areas in western Oregon and western Washington; these stratum were combined because of an inadequate sample population in western Washington.

3/Samples selected randomly from all areas harvested since January 1, 1981; a large majority of samples were from partial-cut areas, the predominant practice in this stratum.

4/Samples selected randomly from all areas harvested since January 1, 1981; samples were chosen from all harvest methods and ownership classes.

Sources: Howard 1981a, 1984.

Table 32—Average net per-acre volume (wood and bark) of logging residue; by area, owner class, and harvest method; in Idaho, Montana, Oregon, and Washington

Area and owner class	Harvest method	
	Clearcut	Partial cut
	<u>Cubic feet per acre</u>	
Idaho:		
National Forest	2,182	1,701
Other public	--	<u>1/1,182</u>
Private	--	<u>1/824</u>
Western Oregon:		
National Forest	2,471	<u>2/1,488</u>
Other public	2,642	1,184
Private	2,070	1,537
Western Washington		
National Forest	2,497	<u>2/1,488</u>
Other public	2,110	895
Private	1,331	992
Eastern Oregon		
Public	--	1/553
Private	--	<u>1/534</u>
Eastern Washington		
Public	--	1/670
Private	--	<u>1/394</u>
Montana:		
Public	1,594	1,100
Private	--	3/994
Lodgepole pine	--	<u>4/1,321</u>

-- = not applicable.

1/Samples selected randomly from all areas harvested since January 1, 1979; a large majority of samples were from partial-cut areas, the predominant practice in this stratum.

2/This figure represents an average of cutover areas in western Oregon and western Washington; these stratum were combined because of an inadequate sample population in western Washington.

3/Samples selected randomly from all areas harvested since January 1, 1981; a large majority of samples were from partial-cut areas, the predominant practice in this stratum.

4/Samples selected randomly from all areas harvested since January 1, 1981; samples were chosen from all harvest methods and ownership classes.

Sources: Howard 1981a, 1984.

Glossary

Clearcut: A harvest method in which all, or nearly all, trees in a stand of timber are cut in one operation.

Cutover area: Synonymous with sample unit or sample area; the area encompassing a single harvest operation (for example; a clearcut).

Diameter

Intersection: Diameter of residue pieces measured inside the bark (i.b.) at the point residue intersects a line transect.

Small-end: Diameter measured inside the bark (i.b.) at the smallest end of a piece of residue, to a 3.0 inch minimum.

Large-end: Diameter measured inside the bark (i.b.) at the largest end of a piece of residue, no minimum or maximum.

Harvest volume: Net scaled volume of timber removed from a cutover area during harvesting, expressed in thousand board feet (Scribner log scale) per acre (MBF/AC).

Line transect: A vertical sampling plane, with no width, along which all intersecting residue pieces are measured.

Logging residue

General: All down and dead woody material existing on an area after timber harvest is completed.

Specific: All logging residue (as defined above) 3.01 inches and larger in diameter inside bark (d.i.b.) and 1.0 foot and longer in length, including limbs, slabs, and splinters.

MBF: 1,000 board feet of logs, a measure of the volume of timber harvested.

Owner class

Private: Lands owned by private individuals, forest industries, or other corporations.

Public: Lands owned by the public or managed by a public agency.

Partial cut: A harvest method in which portions of a stand of timber are cut during a number of entries over time; precommercial thinnings are not included.

Residue volume

Gross: Volume of a piece of residue measured only by its external dimensions; includes rot, cracks, and missing parts.

Net: The usable portion of a piece of residue; for this report usability is based on physical chippability of the material.

Chippability: Condition of residue that is sound enough to be physically handled and is capable of producing usable chips; includes residue exhibiting early stages of wet or dry rot.

Live: Residue from trees that were alive before they were cut or were knocked down during harvest.

Dead: Residue from trees or portions of trees that were dead before harvest.

Cull: Residue from trees that were cull (less than 25 percent sound) at the time of harvest.

Stratum: A category of timber harvest area defined for this study by ownership class, harvest method, and forest type.

Supply zone: A uniquely defined area containing timber determined to be potentially available for a processing facility.

YUM (or PUM): Terms used by the USDA Forest Service for large piles of residue that have been yarded or bulldozed to a common location: if the residue has been piled with some degree of uniformity it is referred to as a PUM (piled unmerchantable material); otherwise, the term YUM (yarded unmerchantable material) is used.

Howard, James O.; Bulgrin, Julianne K. Estimators and characteristics of logging residue in California. Res. Pap. PNW-355. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; **1986**. 81 p.

Ratios are presented for estimating volume and characteristics of logging residue in California. The ratios relate cubic-foot volume of residue to thousand board feet of timber harvested and to acres harvested. Tables show gross and net volume of residue, with and without bark, by diameter and length classes, by number of pieces per acre, by softwoods and hardwoods, by percent soundness, and by degree of slope and distance to roads.

Keywords: Slash, residue management, residue estimation, California.

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